PUBLIC WORKS

city county and state

September 1950

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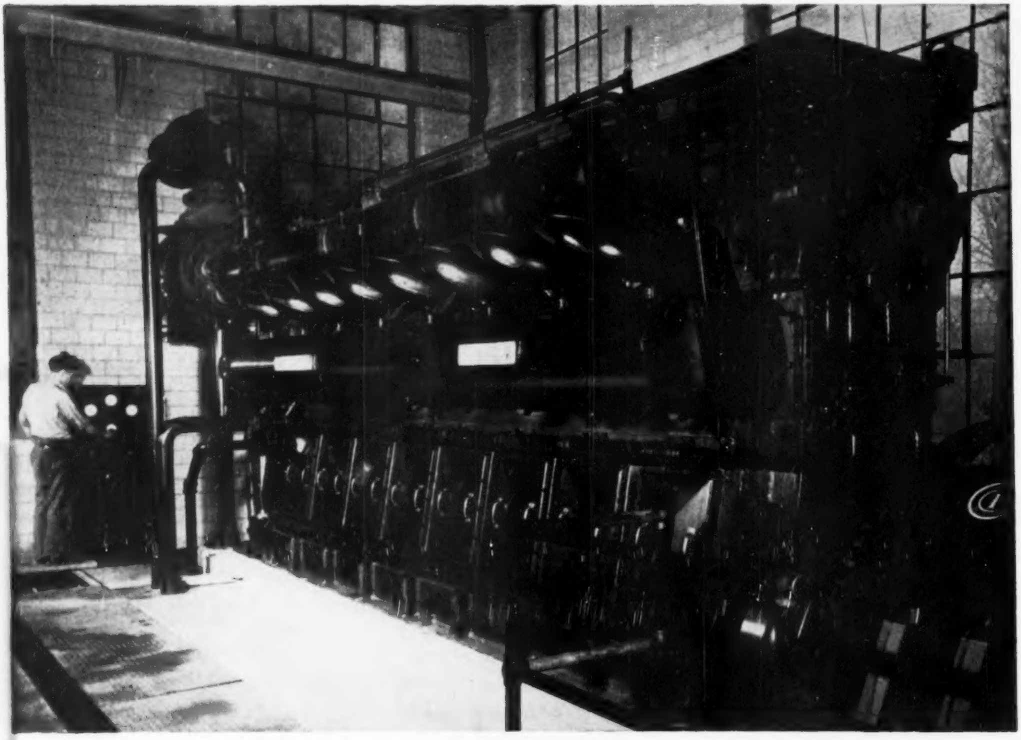

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THE ENGINEERING AUTHORITY IN THE CITY-COUNTY FIELD

Edited by

W. A. HARDENBERGH and A. PRESCOTT FOLWELL

CONTENTS

FOR SEPTEMBER, 1950

PUBLIC WORKS DIGESTS

PUBLIC WORKS MAGAZINE

PUBLIC WORKS ENGINEERING DATA

DEPARTMENTS AND SECTIONS

Price of this issue $1.00

The 1950 volume of Public Works will be available on microfilm through University Microfilms, 313 N. First St., Ann Arbor, Mich.

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THE EDITOR'S PAGE

Getting Ready for Winter

THE hot summer months are the time when planning for winter work and winter emergencies must be done. Aside from the routine, and possibly boring, work of planning snow-plowing routes, checking up on the status of plows and trucks, arranging for salt or grit application to icy streets, and estimating the needs for extra men, it might be well to spend some time on getting familiar with the improved equipment and materials that have been developed during the past year. Checking back through the files of this magazine, not only on those sections devoted to new equipment, but also the several articles telling how county engineers have used equipment more effectively, will, we believe pay off handsomely.

No attempt will be made here to enumerate the various improvements to, and the new, plows, conversion units, attachments and salt and grit spreaders that have been described; nor will attention be called to the many advantages of 2-way radio for snow fighting. But we do urge planners for winter work to take a bit of time off and check over the recent issues of this and other magazines. We are confident that they will find in these magazines rich repayment for the time they spend.

Labor vs Equipment, or Doing More Work at Lower Cost

BECAUSE we believe firmly that no community can any longer afford to do work by hand that can possibly be done by equipment, we are publishing an unusual amount of editorial material bearing on this subject. In one field, we have the problem of sewage sludge disposal at sewage treatment plants, and a series of articles is now being run describing the uses and applications of vacuum filters for dewatering sludge mechanically, and avoiding the hand labor necessary to remove it from drying beds. In another field, we have published four articles telling how county engineers have used equipment most effectively; and this will presently be supplemented with several articles covering the use of equipment by city engineers. In between, are many articles that show special applications of equipment to jobs.

We appreciate fully the difficulties that confront city and county engineers, water works superintendents and others who are charged with construction and maintenance work, when they present requests for the purchase of additional equipment to city officials. However, we believe that, with a sound justification of the advantages that will be derived from the use the specific equipment, authorization generally can be obtained. In preparing such justification the cost of doing the work with the existing equipment (or by hand) should be assembled and compared to the cost with modern equipment. Such data should be assembled just as carefully, or even more carefully, than a cost estimate for a new structure. Consideration ought also to be given to other factors: For instance, how much has it cost in repairs and in new construction that might not have been needed if a sewer system had been properly cleaned and maintained, using adequate modern equipment.

Such figures are not always available; however, those that apply to doing present jobs by hand or with outmoded and wornout equipment ought to be reasonably obtainable. And if they are compared on a cold engineering basis with what the work can be done for with modern equipment, purchase authorizations will come much easier.

Tidal Water Pollution by Small Boats

POLLUTION of tidal waters by sewage and refuse from pleasure craft has presented a serious problem in some parts of Chesapeake Bay. Not only is trash and garbage thrown overboard, creating a visual nuisance, but the sewage discharges from these many small boats may endanger oyster beds and bathing areas. The problem is not a new one; it occurred during the recent war in many harbors where there were heavy concentrations of ships. Nor is it limited to Chesapeake Bay. It is, however, difficult to handle.

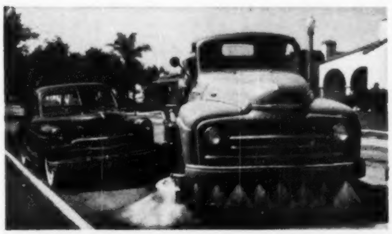
A campaign of education is under way in Maryland to reduce the seriousness of this problem. To your editor, it appears that this cannot be relied on to accomplish the desired ends. Too many people can't read; or they forget; and anyway, what are they going to do—move out in the middle of the channel before flushing the toilet or scraping the garbage off the breakfast plates? It looks to us that eventually boats are going to have to install such devices as garbage grinders and chemical toilet tanks. Let's hear from our inventors; they should have some answers. In the meantime, it would be a fine thing for the Conference of State Sanitary Engineers and the Sanitary Engineering Committee of the National Research Council to give consideration to factors of design for waste disposal for small craft, so that boat manufacturers and boat yards would have effective standards for installing this needed equipment.

ON DISPLAY — BOOTH B-4 — PUBLIC WORKS CONGRESS — NEW YORK CITY

EVERY FEATURE FOR LOW COST SWEEPING

You'll say—"*Mobil-Sweeper is best*," when you see how easily it tackles tough street sweeping assignments like deep and wide gutters—sharp curb returns—steep hills—under low-hanging trees or protrusions . . . *plus* unexcelled performance on level terrain.

COSTS LESS TO SWEEP—The Mobil-Sweeper cleans more pavement with fewer stops—because the big 2⅔ cu. yd. dirt hopper is filled to utmost capacity every time by the efficient non-clog conveying elevator. Whether your community uses the central dumping system or drives direct to the dump with each load, Mobil-Sweeper's large capacity saves money. Deadheading from city dump or service yard to sweeping area takes less time because only Mobil-Sweeper can travel at maximum traffic speeds up to 55 m.p.h., when not sweeping. Where direct trips to the dump are feasible, Mobil-Sweeper saves the expense of a follow-up truck and crew.



SWEEPS CLEANER—With the big, full-floating pickup broom and right and left gutter brooms you can sweep a 10 ft. swath . . . with pickup broom and one gutter broom a 7′3″ swath. Our especially designed gutter broom whisks refuse from even the deepest gutters with a thoroughness that assures cleaner streets.

SAFEST SWEEPER TO OPERATE—Drivers are protected by a steel-top cab and shatter-proof windshields (standard equipment). Self-equalizing 4-wheel hydraulic brakes provide greater safety. And on steep hills or rough pavement you can't beat 4-wheel stability. These and many more features make Mobil-Sweeper your best buy. Write for details on

CLEANER STREETS AT LOWER COST

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THE CONVEYOR CO.
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Please send catalog with complete details and specifications for the Mobil-Sweeper.

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MOBIL-SWEEPER
DIVISION OF
THE CONVEYOR CO.
3260 E. SLAUSON AVENUE
LOS ANGELES 58, CALIF.

Automotive Shovel With Hydraulic Crowd and Hoist Speeds Up Excavation Work

Unit Reduces Excavation Costs; Loads Up To One Cubic Yard A Minute

MOVING SHOVEL LOADERS to and from jobs is one of the most expensive unproductive costs in excavation work. Contractors lose hundreds of hours and spend thousands of dollars annually moving this equipment. Developments since the war show that contractors can be relieved greatly of these costs. One of the most successful developments has been the manufacture of the rubber-tired Dempster-Diggster shovel loader that travels at truck speeds.

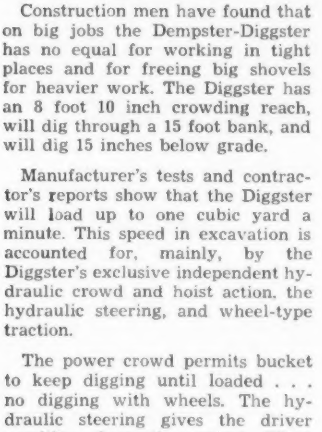
THE DEMPSTER-DIGGSTER is shown here digging out a 15 foot bank of hard chert. The power crowd permits bucket to keep digging until loaded . . . no digging with wheels.

Digs Through 15 Foot Bank

Construction men have found that on big jobs the Dempster-Diggster has no equal for working in tight places and for freeing big shovels for heavier work. The Diggster has an 8 foot 10 inch crowding reach, will dig through a 15 foot bank, and will dig 15 inches below grade.

Manufacturer's tests and contractor's reports show that the Diggster will load up to one cubic yard a minute. This speed in excavation is accounted for, mainly, by the Diggster's exclusive independent hydraulic crowd and hoist action, the hydraulic steering, and wheel-type traction.

The power crowd permits bucket to keep digging until loaded . . . no digging with wheels. The hydraulic steering gives the driver sensitive, finger-tip control. When accelerated, a one-handed twist of the steering wheel puts the machine in any desired position. By operating on rubber-tired wheels, the Diggster, of course, can move at the fastest possible speed.



ENCLOSED STEEL CAB protects operator against inclement weather.

Not A Fair Weather Machine Only

Under adverse conditions on a state highway near Charleston, W. Va., recently, the Diggster loaded 150 cubic yards of sticky blue clay in only three hours. The work consisted of cleaning up slides on 14 foot embankments on both sides of a concrete road. The weather was not cooperative, inasmuch as considerable rain fell the night before. But the Diggster showed no tendency to slide. The job foreman stated that it loaded more material in two hours than the ⅜ and ½ cubic yard truck shovels normally did in an entire day. This and many other operations in inclement weather have proved that the Diggster is not a fair weather machine only.

The Dempster-Diggster has a 15 foot turning radius, is 20 feet long when bucket is in traveling position, and is nine feet and six inches in height.

Four standard interchangeable buckets of two types are available. Digging buckets with four bottom teeth in 1 and 1¼ cubic yard (heaped) capacities. Materials handling buckets in 1½ and 2 cubic yard (struck) capacities.

Crawler Traction Available

For fast, efficient operation in difficult terrain, the Diggster is available with crawler-type traction.

Complete information and prices may be obtained by writing the manufacturer, Dempster Brothers, Inc., Knoxville, Tenn.

DEMPSTER DIGGSTER

DEMPSTER BROTHERS
990 Dempster Bldg.
Knoxville 17, Tennessee

When you need special information—consult READERS' SERVICE DEPT. on pages 101-105.

You can stretch your snow dollars, as well as your road and street dollars, by investing in equipment with all-round, all-year usefulness — versatile Allis-Chalmers Motor Graders.

They are not tied down to special jobs. Allis-Chalmers Motor Graders are designed and engineered for toughest snow removal work . . . as well as for handling grading, scarifying, oil mix, ditching and bank sloping.

An exclusive tubular frame absorbs shocks and strains, also protects control rods. Tandem chain drive and proper weight distribution provides the traction to keep driving ahead in toughest snow plowing. There is instant starting and operation on diesel fuel . . . smooth, economical, dependable 2-cycle diesel power. High travel speeds enable you to go quickly from one job to another. Every operator comfort . . . cabs and other accessories.

There is a right size Allis-Chalmers Motor Grader to fit your needs . . . and pocketbook. Get the full story from your A-C dealer . . . NOW! Make your SNOW DOLLARS BUY MORE.

CHOOSE THE GRADER TO FIT THE JOB FROM THIS COMPLETE LINE

A-C MOTOR GRADERS with Baker "V" Plows

MODEL	BRAKE HP.	ENGINE
AD-4	104	2-Cycle Diesel
AD-3	78	2-Cycle Diesel
BD-3	78	2-Cycle Diesel
BD-2	50.5	2-Cycle Diesel
D	34.7	Gasoline

(Wings available for AD and BD models . . . scarifiers for all models, for removing ice. Also: snow bucket for Model D.)

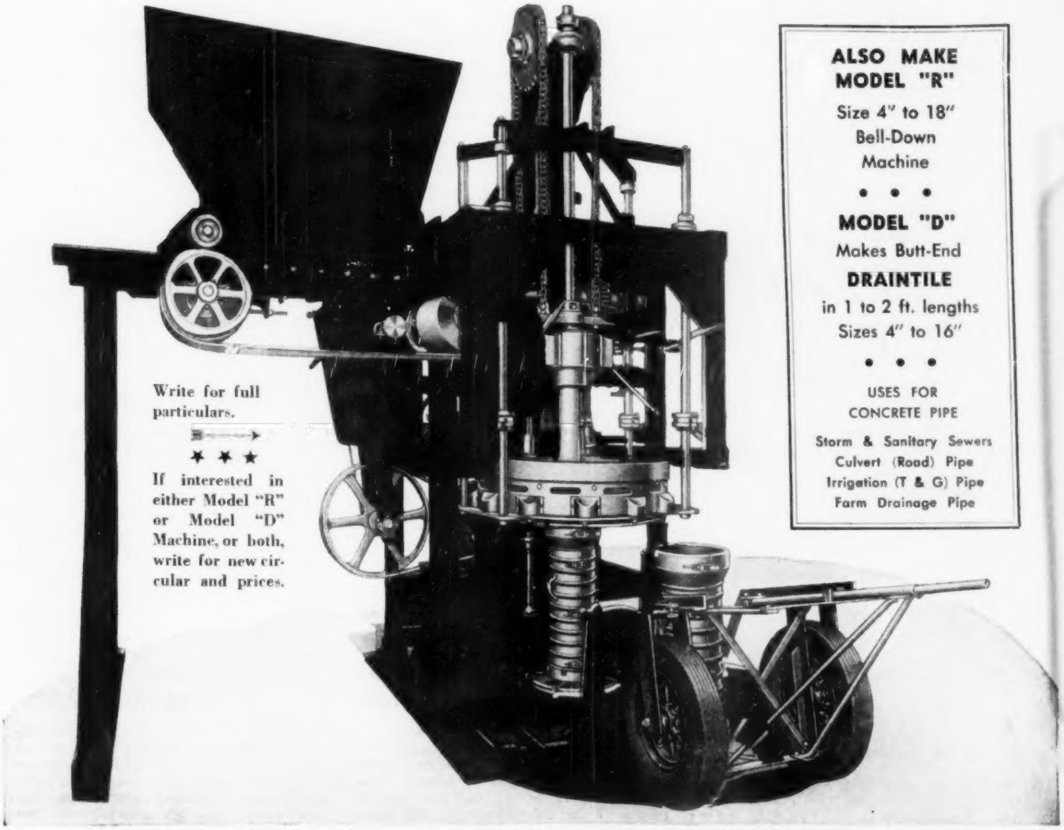
LOAD or PLOW SNOW with the versatile Model D . . . scarify, maintain roads and streets. Only low-cost motor grader with tandem drive and other big grader features.

. . . for greater production . . . for easier operation . . . for simplified servicing

ALLIS-CHALMERS

TRACTOR DIVISION • MILWAUKEE 1, U. S. A.

When you need special information—consult READERS' SERVICE DEPT. on pages 101-105.



When you need special information—consult READERS' SERVICE DEPT. on pages 101-105.

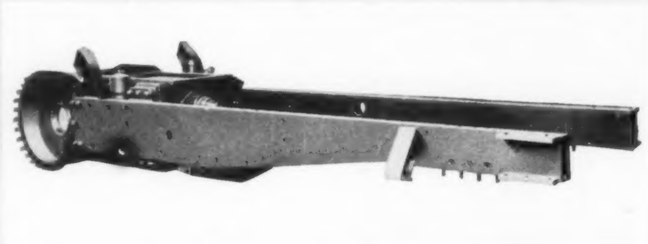
Where tax savings

"CAT" EQUIPMENT SPEAKS THE TAXPAYER'S

TAX savings are also the "mother language" of the public official. In a "Caterpillar" Tractor-Wagon team like the one shown on opposite page, highway and public works heads can equip their departments with a high-speed heavy-hauling outfit that has no superior. It's versatile—usable for many jobs: quick hauling to waste areas, speedy hauling of road materials from gravel plant, borrow pit or central mixer. With a No. 10 Scraper alternating with the W10 Wagon, the "Cat" DW10 Tractor is excellent for building roads and streets. It rounds out ideally a county's fleet of motor graders, tractors and 'dozers for the building of vital farm-to-market roads.

The "Caterpillar" DW10 is one of the greatest successes in heavy wheel tractor history. Look at the work-capacity features and the honest-to-goodness quality "Caterpillar" has built into it. (Nothing is too trivial or "too much trouble" to make these products the finest investments of their kind.) Below are a few points of evidence.

CATERPILLAR TRACTOR CO. • PEORIA, ILLINOIS



Savings through STRENGTH

The DW10 is built to handle big loads. Main frame—composed of two strong box-welded members securely fastened to transmission case—is 12 inches deep at the rear, where the load is carried. The rigid structures have several times the resistance to twisting strains that channel sections of the same size afford. Great frame strength and ruggedness provide a firm foundation for the components of this powerful wheel tractor.

Savings through QUALITY

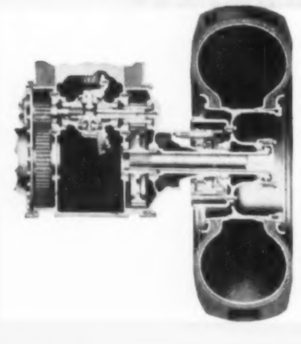
To withstand the demands of continuous hard work, the final drive assembly of the DW10 is rugged yet finely engineered. It embodies precision-built bevel gears, full-floating rear axle, crown-shaved "Hi-Electro" hardened final drive gears, optional gear ratios, welded steel transmission case, cast steel final drive housing, air-operated brakes. Sound construction!

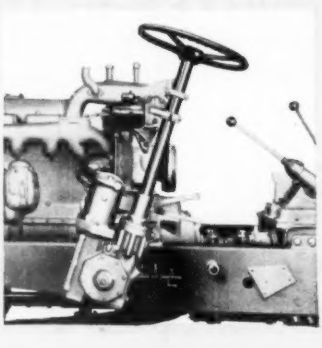
Savings through EASE of OPERATION

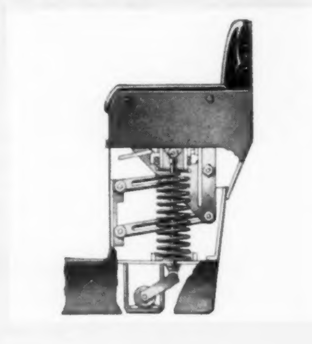
A hydraulic booster gives the DW10 passenger-car steering ease and absorbs shock loads when taking rutted roads and downhill runs. Yet the steering system can be operated independently of the booster feature. A fine safety feature in the highest sense!

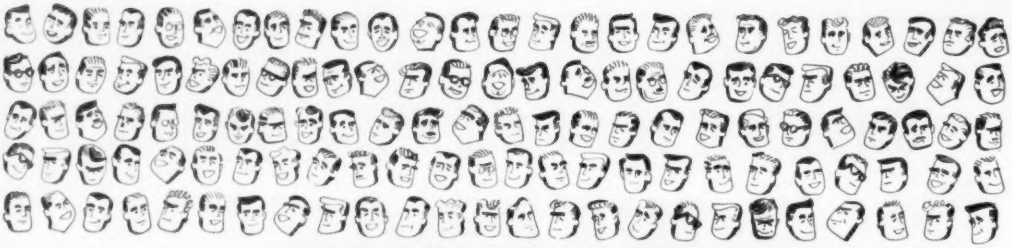
Savings through OPERATOR COMFORT

The DW10 is built for easy, safe driving. Besides finger-tip steering, excellent visibility, handy controls, and minimum "stretch," the DW10 provides easy riding through airfoam rubber seat cushion *plus* seat springs that are adjustable to operator's weight.



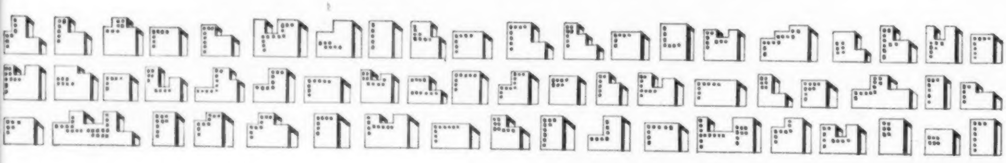




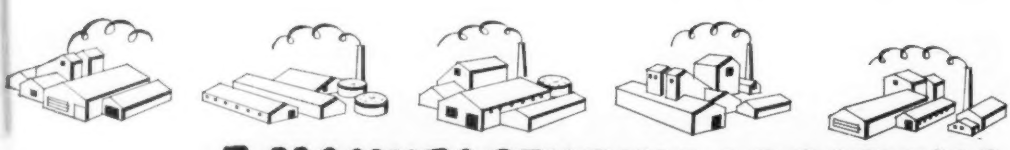


257 FIELD REPRESENTATIVES

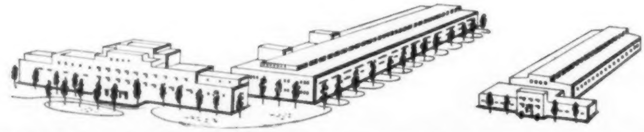
48 INSTALLATION INSTRUCTORS



58 SALES OFFICES



5 MANUFACTURING LOCATIONS



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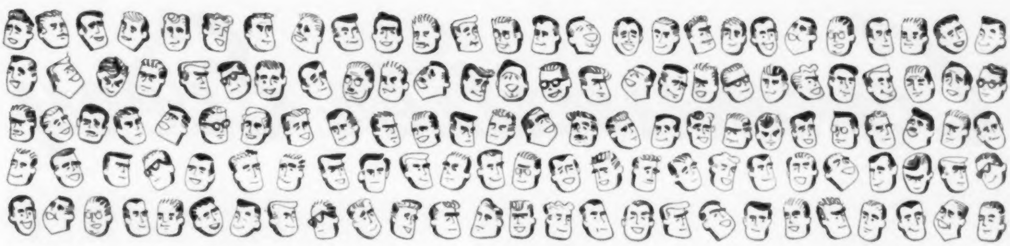
JOHNS-MANVILLE JM PRODUCTS

Johns-Manville



At your service—

. . . a complete, nationwide
TRANSITE PIPE ORGANIZATION

Here is an organization which, over the past many years, has helped to bring a better, a more efficient and a more economical means of water transportation to many hundreds of American cities and towns.

Its facilities include more than 250 field representatives with headquarters in 58 cities. It also comprises a staff of competent installation instructors who explain recommended installation practices to pipe-laying crews. This Johns-Manville service is an important factor in helping to assure the installation economies as well as the long-term *overall* economies that go with Transite Pressure Pipe.

Behind this field organization are the modern production methods which assure the high quality of the finished product. These begin with careful selection of raw materials and are continued through the special processing operations to the final tests which each individual length of pipe must undergo before shipment is made. Five conveniently located plants now serve Transite Pipe users from coast to coast.

And back of all this is engineering—and research. For without them, the plus values that have been built into Transite Pipe would not have been possible. Today, in the new J-M Research Center, the engineer and the technician continue to find new answers to old problems. Their work is an indispensable part of the complete Transite Pipe service which Johns-Manville offers the water works industry. For further information, write Johns-Manville, Box 290, New York 16, N. Y.

***TRANSITE is a Johns-Manville registered trade mark**

TRANSITE ASBESTOS—CEMENT PRESSURE PIPE

F O R B E T T E R W A T E R S E R V I C E

When you need special information—consult READERS' SERVICE DEPT. on pages 101-105.

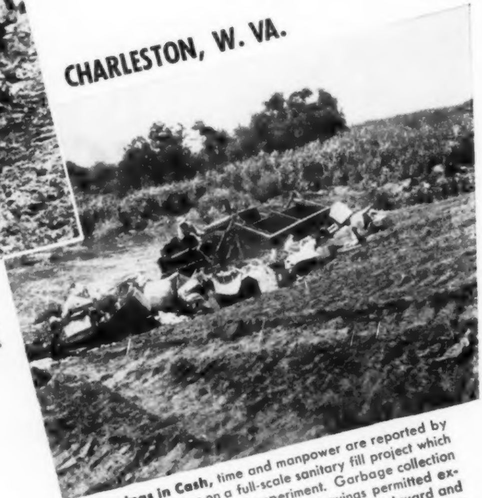
Communities Every

THE DROTT

DALLAS, TEXAS

Low Cost Disposal—In a single year, more than 70,000 tons of garbage and 104,000 cubic yards of brush are buried in sanitary fills at a cost of 43½ cents per ton. Starting with three Drott-International Tractor-Bullclam units in 1944, Dallas now has nine of these in operation. Land owners grant free use of their lowlands for sanitary fill operation, to get their lands raised and level.

CHARLESTON, W. VA.



Savings in Cash, time and manpower are reported by Mayor Andrews on a full-scale sanitary fill project which started as a fly-control experiment. Garbage collection service increased one-third, cash savings permitted extending the collection service to an additional ward and speed of operation allowed the dropping of at least one man from each of five trucks, thereby increasing the cash savings. Instead of objecting, land owners request the city to use their properties. And many other benefits are cited as the result of changing over to Drott sanitary fill methods.

International TD-14A Crawler tractor with Drott 2-yard Bullclam. Also available: TD-9 with 1-yard Bullclam and TD-18A with 3-yard Bullclam.

INTERNATIONAL HARVESTER

When writing, we will appreciate your mentioning PUBLIC WORKS

where Recommend...

INTERNATIONAL *Sanitary Fill Builder*

$58,400 Saved in investment, and an operating cash saving of 64 cents per ton of refuse handled, are the direct result of converting from incineration to sanitary fill methods of disposal, according to public health engineer, J. A. Willman. "No fly, rat or mosquito breeding; no odors or smoke," he says.

RIVERSIDE CAL.

The Changing Scene from an insect and rat-infested dump of garbage and rubbish piles, to the clean, Drott *ramp-type sanitary fill* is portrayed in this photograph. The ramp method, introduced by Drott, cuts out all waste motion and lost time in sanitary-fill construction and operation. The finished fill will be level with elevation at left.

Your community, too, can save money, guard public health and make wastelands valuable while disposing of refuse and garbage. The *One-man Sanitary Fill Builder*—an International Crawler tractor and Drott Bullclam combination—will do the whole job.

No Other Equipment Needed

Because this one machine does the entire job of sanitary-fill construction and operation—digging, compacting, covering and finishing—no auxiliary equipment is needed. No burning of refuse, either!

A Simple, Sanitary Operation

Daily accumulations are buried, compacted and covered in "cells"—never left exposed for pests to breed in. The Drott-International tractor and bullclam does it all, systematically and at a cost that returns valuable cash savings. Open-dump and burner methods are—by comparison—expensive and offensive. Eliminate them. Gain the valuable benefits Drott and International can bring your community, with a modern sanitary fill.

For complete information, without obligation, write Drott Manufacturing Corp., Milwaukee 8, Wisconsin—or contact your International Industrial Power Distributor.

DROTT MANUFACTURING CORP.
Milwaukee

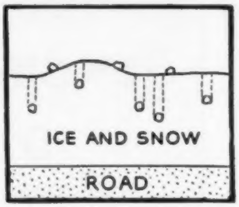
INTERNATIONAL HARVESTER COMPANY
Chicago

DROTT-INTERNATIONAL
TRACTOR AND BULLCLAM COMBINATION

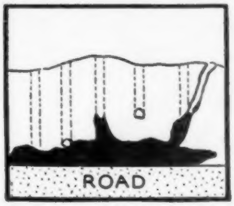
When you need special information—consult READERS' SERVICE DEPT. on pages 101-105.

HERE'S HOW IT WORKS

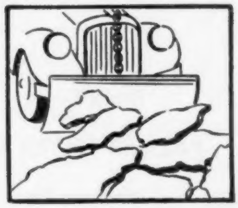
Sterling Auger-Action Rock Salt can be used in any mechanical spreader. Requires no special treatment.



Each Sterling Auger-Action Rock Salt crystal bores a hole its own size in ice or snow.



Salt crystal reaches pavement . . . becomes brine. Brine breaks the bond between road surface and ice.



Broken ice can be removed with one pass of plow or scraper. Passage of vehicles clears heavy traffic spots.

CITY OF ROCHESTER, N. Y.

Comparative Costs

STRAIGHT ROCK SALT vs. SALT & CINDERS

SALT-CINDER MIXTURE (1947-48) (370 MILES SERVICED)

COST OF CINDERS Delivered Storage Yard, Per Cubic Yard	$ 1.40
COST OF PILING Per Cubic Yard	.20
COST OF SALT ADDED (150# Per Cu. Yd. Cinders), Per Cu. Yd.	.67
COST OF PILING SALT Per Cubic Yard	.20
COST OF LOADING SPREADER At Time of Storm, Per Cubic Yard	.20
COST OF SPREADING Salt-Cinder Mixture, Per Cubic Yard	.43
SPREADING COST PER CUBIC YARD	$ 3.10
Rate: 3 Yards	3
COST PER MILE FOR SALT-CINDER MIXTURE LAID DOWN	$ 9.30
ADD: Spring Cleaning Cost to Remove Cinders from Basins and Receivers	$ 1.50
TOTAL COST PER MILE FOR SALT-CINDER MIXTURE	$10.80

STRAIGHT ROCK SALT (1949-50) (370 MILES SERVICED)

COST OF SALT ($9.50 Per Ton Delivered Unloaded Storage Yard)	$ 9.50
COST OF PILING SALT Per Ton	.20
COST OF LOADING SPREADER TRUCK At Time of Storm, Per Ton	.20
COST OF SPREADING SALT (12 Tons Salt, 1000# Per Mile, Truck Cost $.30 Per Mile, Labor $2.20 Per Hour), Per Ton	.85
COST OF SALT LAID Per Ton	$10.75
SPREADING RATE: 2 Miles Per Ton	
TOTAL COST PER MILE USING STRAIGHT ROCK SALT	$ 5.38

OVER $2000.00 SAVED EVERY COVERAGE

STERLING AUGER-ACTION ROCK SALT

INTERNATIONAL SALT COMPANY, INC.

SCRANTON, PA.

When you need special information—consult READERS' SERVICE DEPT. on pages 101-105.

Public Works ENGINEERING DATA

Operating Data from the Minneapolis St. Paul Sewage Treatment Plant

Average flow of sewage in 1949, according to the annual report of the Minneapolis-St. Paul Sanitary District, Kerwin L. Mick, Chief Engineer, was 124.8 mgd. Sewage flow per capita averaged 131 gals. per day; suspended solids in the raw sewage were 0.30 lb. per person per day; and BOD was 0.21 lb. With an average detention time of 1.7 hours, removal of suspended solids was 73.1%, and of BOD 40.8% with plain sedimentation. With flocculation, which was used briefly in July, removals were improved. Using 1.0 cu. ft. of air per minute per foot of tank length, removal of BOD was 44.4% and of SS 79.6%; with 1.5 cu. ft. of air, removals were 49.0% for BOD and 80.3% for SS.

Grit removal averaged 4.7 cu. ft. per million gallons of sewage and contained 10.2% of volatile solids. Screenings removed amounted to 0.9 cu. ft. per million gallons. During normal dry weather flows, velocities in the grit chamber were about 1.2 fs.

Ferric sulfate has been used for conditioning sludge for vacuum filtration and, during 1949, the average dosage was 1.63% of ferric sulfate (equivalent to 0.94% of ferric chloride) and 2.95% lime (expressed as calcium oxide) on the basis of dry solids. The rate of filtration, also based on dry solids, was 3.22 pounds per hour per square foot of filter area. The cost of vacuum filtration was $3.48 per ton of dry solids, while the cost of incineration was $1.73 on the same basis.

How To Maintain Dirt and Gravel Roads

Standard practice in dirt road maintenance is to pick up the gravel and loose material from both sides of the road and windrow it to the center in one or more round trips. Then the windrow can be spread back toward the sides in one pass by setting the blade straight across; or it can be spread by making another round trip casting half of the windrow to either side. This method enables the operator to keep the desired crown and to distribute evenly the loose material on both sides of the road.

Too often, operators cut too much material away from the berm, leaving a ridge of sod or dirt on the edge of the shoulder. This results in poor drainage from the road surface with water standing along the edges of the driving surface; and it may also cause washouts on the shoulder when this water finds a place to run off.

Berms must be kept lower than the driving surface. It is often necessary to cut the berm down with the motor grader and remove the material with trucks. If berm is to be cut away, it is advisable to move any gravel away from the shoulder before cutting the sod away.

Dirt surfaced roads become hard in some localities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during hot dry summer months. These roads should be maintained after rain storms or damp weather when the dirt is in a workable condition. Hard surfaces may require a scarifier application before satisfactory blading can be accomplished.

The information contained in this article was furnished by the Allis-Chalmers Tractor Division Civil Engineering Department and was published in the Allis-Chalmers Reporter.

Dual-Fuel Engines for Long Island Sewage Treatment Plant

Five supercharged dual-fuel Worthington engines will be installed in the new sewage treatment plant being built at Bay Park, L. I., for the Nassau County sewerage system. These will provide 2,925 hp. Two engines will drive generators; two others will drive Roots blowers; and the fifth will be a combination unit. It is expected that the plant will produce about 170,000 cu. ft. of gas per day, and will treat 27 mgd of sewage.

Water System Features Automatic Controls

A water treatment plant for the removal of sulphur and carbon dioxide was recently installed by Yazoo City, Miss. The installation was made and the equipment furnished by Layne-Central. After passage through a degasifier and aerator, the water passes to a 30,000-gal. steel storage reservoir from which it is fed into the distribution system at 100 pounds pressure. The well pump is connected to a high and low water level control, which automatically turns the pump on and off. A time control is also employed.

The Layne pump used for delivering water to the distribution system is mounted on top of the steel tank, which is at ground level. The pump rests on a pipe stand mounted on a base plate set in a separate concrete foundation. The reservoir serves as pump sump and the pump is always primed.

Automotive-Type Diesels Furnish Auxiliary City Power

A satisfactory temporary solution for its expanding power needs has been found by Clayton, N. M., by the use of two 180-hp International automotive diesel engines. Each of these engines drives a 75-kw, 2,300-volt generator. The main power needs of the city are furnished by stationary diesels supplying 1,600 kw. The smaller engines are used to meet peak load demands and to fill in when one of the larger engines is down for maintenance. John B. Callahan, chief mechanic, reports low-cost and satisfactory operation. While larger engines will be purchased in the future, the city has temporarily solved its problem at a saving in capital investment while obtaining satisfactory service.

Backhoe Digs Sewer Trench

A 1½-yd. Marion 362 backhoe has been used on trenching for sanitary sewer construction on the Frank Road job, just outside of the city limits of Columbus, O. Haddad Constr. Co. is the contractor and the estimated cost of the work is $216,000. The first job was ditching 3,500 ft. for a 42-inch line. During May, the machine trenched about 2,500 ft. In addition to this line, the contractor will construct 9,500 ft. of 30, 27 and 21-inch line.

Decatur meets growing water demands with more elevated storage capacity

In order to meet a 61 per cent increase in water consumption per capita, Decatur, Alabama recently installed its third Horton elevated water tank. This new 2,000,000-gallon addition shown at the right now boosts the city's total elevated storage capacity to 3,300,000 gallons.

Turning to elevated tanks when greater water storage is needed has become the regular practice of growing cities everywhere. Engineers realize that to maintain uniform water pressures throughout the city and to provide a water reserve for emergencies, elevated tanks are the efficient solution.

Write our nearest office for full details. There is no obligation.

2,000,000 gal. radial-cone tank installed in 1949.

1,000,000 gal. radial-cone tank installed in 1947.

Engineering Data for Decatur Water Works System

	1947	1949
Number of elevated tanks	2	3
Total elevated storage	1,300,000 gals.	3,300,000 gals.
Customers served	4600	5250
Industrial	49	250
Domestic	4551	5000
Per capita consumption	99 gals. daily	160 gals. daily
Max. daily consumption rate	2,500,000	4,000,000
Min. daily consumption rate	2,000,000	3,000,000
Insurance rate	3	2

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Los Angeles 14 .... 1508 General Petroleum Bldg.
New York 6 .... 3316–165 Broadway Bldg.
Philadelphia 3 .... 1648–1700 Walnut St. Bldg.
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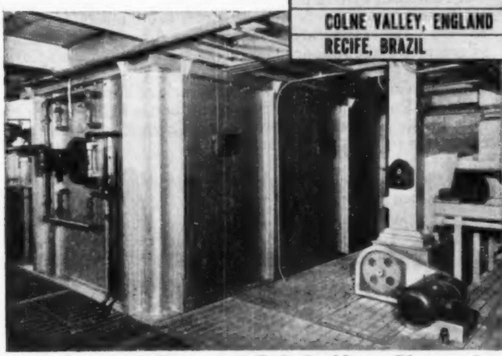
CALUMET			✓	✓
SOUTHWEST			✓	✓
WEST SOUTHWEST			✓	✓
BUFFALO, NEW YORK	✓			✓
TENAFLY, NEW JERSEY		✓		✓
SPRINGFIELD, MASS.			✓	
NEENAH-MENASHA, WIS.	✓			✓
WATERVLIET, NEW YORK	✓			✓
CUYAHOGA FALLS, OHIO	✓			
DULUTH, MINNESOTA			✓	✓
MANITOWOC, WISCONSIN		✓		
SAN DIEGO, CALIFORNIA		✓		✓
STAMFORD, CONNECTICUT			✓	✓
SHEBOYGAN, WISCONSIN		✓		✓
BATTLE CREEK, MICHIGAN		✓		
SAN DIEGO, CALIF. EXTEN.		✓		✓
HOUSTON, TEXAS		✓		
LOS ANGELES, CALIFORNIA			✓	✓
FOND DU LAC, WISCONSIN		✓		✓
SAN FRANCISCO, CALIF.		✓		✓
BALTIMORE, MARYLAND		✓		
WATERBURY, CONNECTICUT			✓	✓
COLNE VALLEY, ENGLAND			✓	✓
RECIFE, BRAZIL		✓		



C-E Raymond System at Duluth, Minn. Photo taken from operating floor showing part of furnace.

All inquiries on the C-E Raymond System should be directed to the nearest office of The Dorr Company, world sales representatives in the Sanitary Engineering Field.

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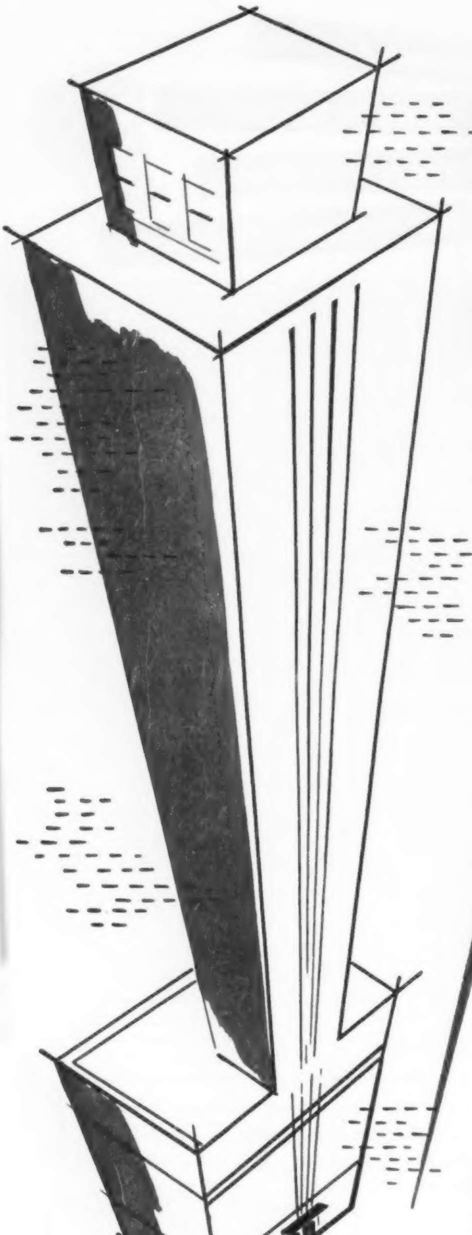

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These seven articles cover Volume of Flow, Primary Settling, Sludge Digestion and Disposal, Activated Sludge and Small Trickling Filters Details and Design. Included are plant layouts, tables and design details especially adapted to small plants together with money-saving suggestions.

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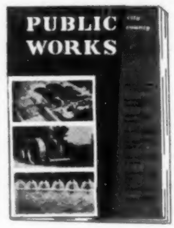

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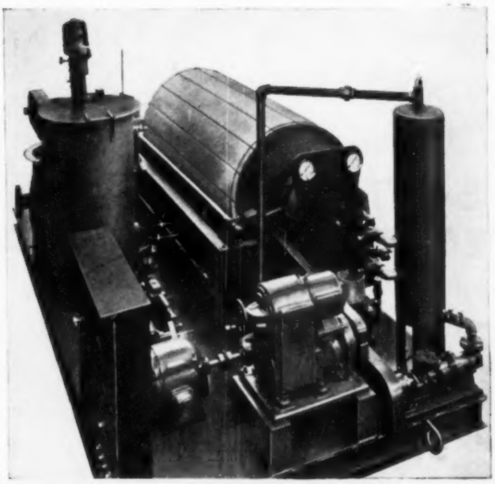

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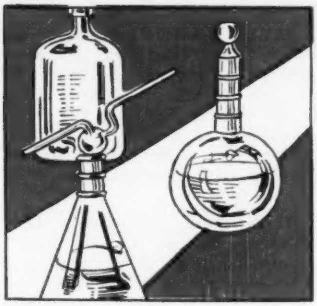


PUBLIC WORKS MAGAZINE

SEPTEMBER, 1950 VOL. 81 • NO. 9

What you should know about FLUORIDATION OF WATER SUPPLIES

At various places throughout the United States studies of the fluoridation of water supplies as a means of reducing tooth decay have been carried on. The author presents here 47 of the more commonly asked questions about fluoridation, together with the answers based on best present information.

HENRY F. MUNROE

Chemical Engineer, Proportioneers, Inc.

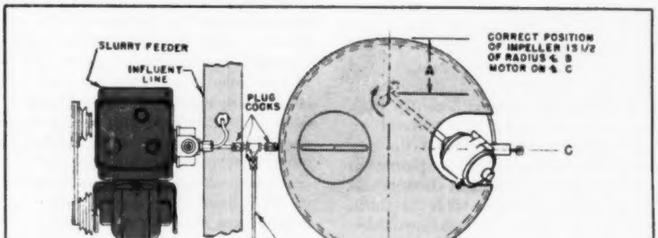
1. What do we mean by fluoridation? By fluoridation we mean the addition of a fluoride compound, such as sodium fluoride, hydrofluoric acid or sodium silico fluoride, to augment the natural fluoride content of the water to reduce the incidence of dental caries (cavities in the teeth) while preventing fluorosis. Mottling of the enamel of the teeth with brown or black stains is an early sign of this.

2. Why is the process called fluoridation and not fluorination? The term "fluoridation" is used by the AWWA in preference to "fluorination" because the compounds used are fluorides instead of fluorine gas, which is difficult to handle.

Public Health Aspects

3. What is the optimum fluoride content for the reduction of dental caries? In 1938, Dean discovered an inverse ratio between dental caries in children and the fluoride content of the local water supply. He further determined that cavities were at a minimum when the fluoride content of the local water supply was between 1.0 and 1.5 ppm.

4. Can a person get the optimum amount of fluoride in his regular diet? Bibby reports that the fluoride in foods is not sufficient to provide assistance against tooth decay.



● ***INSTALLATION diagram of a sodium silicofluoride slurry feeder with flushing connections, showing layout.***

5. How long does it take to notice the effects of proper amounts of fluorides? It is generally conceded that there is a long period between the cause and the appearance of a tooth cavity; and most dentists believe that the protective effects of fluoride will require an equally long period. It is difficult to make a positive statement, and the Dental and Public Health Associations believe they should observe the effect of fluoridation over the period required for the formation of the incisors and molars, that is 8 or 10 years. However, an improvement was noted in a 3-year period in the case of displaced Japanese children.

6. How does the fluoride react with the teeth? The exact mechanism is not known. The latest hypothesis recognizes the likelihood of a chemical reaction between the fluorides and the tooth enamel, preventing decalcification.

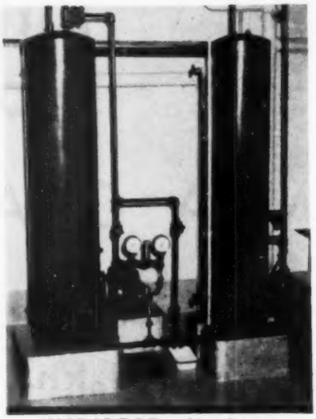
7. How do fluorides prevent tooth decay? Three theories have been advanced. According to one, the fluoride passes to the intestine to the blood to the saliva; however, analysis of the saliva shows no fluorides. Another theory is that the fluoride stays in the mouth and prevents decalcification; however, it is questionable if a sufficiently high concentration of fluoride remains in the mouth long enough to do any good. The most logical explanation seems to be the chemical theory that the fluoride combines with the tooth enamel to form a calcium fluophosphate which is extremely resistant to acids and therefore prevents decalcification.

8. If the prevention of dental caries is a chemical reaction, how do we know that the fluorides exist as ions in the water? According to M. Starr Nichols, (AWWA, 40, 7, July 1948 page 751), "fluorine when naturally present in water in a dilution of 1.0 ppm exists as the fluoride ion. Any fluoride added to a water in like concentration would be present in the form of fluoride ions".

9. Is there any method now in use for using fluorides for treating teeth? A fluoride paste has been painted on by dentists, with excellent results. This method is costly and available only by going to dentists.

10. If fluorides are known to be so beneficial, why are they not added to gums and tooth pastes? The Food and Drug Administration does not permit the addition of fluorides to dentifrices.

11. Have fluorides any selective action in regard to age, sex or race? No. However, some people may be allergic to fluoride treated water and the optimum dose may not be the same for all people.



● ***INDIRECT displacement feeder for hydrofluoric acid application.***

12. How important is the prevention of caries? In Vermont, in World War II, 10% of all draftees were rejected for dental defects alone. Massachusetts spends about 17% of its health appropriation on dental care. It is estimated that each person should spend $25 annually for dental care, whereas fluoridation costs 25 cents per capita. The Commissioner of Health of Milwaukee has estimated that fluoridation in that city will reduce dental bills by $50,000,000.

13. What results can we expect with fluoride treated water? Water treated with fluoride to 1.0 to 1.5 ppm has shown a 30-40% reduction in dental caries in three years. The maximum to be expected is a 50-70% reduction in the decayed-missing-filled rates with less than 10% showing any fluorosis.

14. If there are such savings and benefits to consumers, why are authorities reluctant to proceed? The Dental, Public Health and Water Department officials recognize the benefits from fluoridation, but are awaiting the results of controlled tests now under way.

15. How long will it be before they give their approval? The first indication of the result of controlled fluoridation may be expected about four years from now. The results will give, it is hoped, undisputed evidence of the effect of artificial fluoridation of water on the teeth of children who have consumed such water up to the time of molar formation.

Are Fluorides Objectionable?

16. Are fluorides harmful to the Water Plant Operator? Not when normal precautions are taken. As with many other chemicals, large doses may be harmful. The 20-40 mesh sodium fluoride has no dust and a spray nozzle is used for dissolving, thus eliminating danger to the operator.

17. Is there any danger from drinking fluoride treated water? Controlled tests under way since 1945 have not been completed, but preliminary reports give no indication of any harmful effects. Water treated to a maximum of 1.5 ppm fluorides is satisfactory so far as available data indicate.

18. Is there any danger from over-treatment with fluorides? The addition of fluorides, as with many chemicals, is beneficial with proper dosages, and harmful when excessive doses are taken. Fluorides in water in concentrations above 1.5 ppm produce fluorosis, and concentrations of 6 ppm or more affect many people adversely—children more than adults. With the larger amounts, fluorides are retained in the bones. Toxic effects are reported with concentrations of 180 ppm.

19. Do fluorides cause taste in water? It has been established that fluorides up to 1.5 ppm do not impart any taste to the water.

20. Why do some cities remove fluorides from the water supply? Fluoride concentrations greater than 1.5 ppm produce fluorosis. Effect of increasing concentrations is progressive until at 6.0 ppm practically all consumers are affected.

How Fluorides Are Added

21. How are fluorides added to the water supply? Fluorides are added in either powder or solution form. Greatest accuracy is obtained by the use of saturated solutions and this method is simple and economical for flows up to 10mgd.

22. How is dosage controlled? The solution is the proper selection, installation and care of equipment. Positive displacement feeders deliver exact amounts of chemicals at each stroke and over each time interval. Mechanical or electrical failure results in no feed at all, rather than too much.

23. Are all fluorides added to water in the same way? All fluorides are fed by positive displacement feeders. Sodium fluoride is commonly fed as a solution. Sodium silico fluoride, being relatively in-

soluble, is fed as a slurry. Hydrofluoric acid has also been used.

24. Will all fluorides produce the same result? The reaction between tooth enamel and the fluorides is ionic, and it is generally conceded that any fluoride that will ionize in dilute solution (any commercially available fluoride) will give equal results.

25. Is any other source of fluorides available? Though fluorides are present in foods, the intake from these sources is relatively insignificant.

26. To accomplish reduction of dental cavities, is it necessary to treat water already containing small amounts of fluorides? The purpose is to maintain a concentration of 1.0 to 1.5 ppm. It is necessary only to add enough fluorides to bring the total to the approved dosage.

27. Is there any difference between water naturally containing fluoride and those artificially treated? Chemically, there is no difference insofar as fluoride alone is concerned. The controlled tests now under way should provide a more complete answer, including the effect on industry, on supply systems and on humans.

28. Where are fluorides added to the water? Where wells are the sole source, fluorides are added to the discharge of the pump on the way to the distribution system. With filter plants, fluoride is added after all other processes; however, it may be added before chlorination since a free chlorine residual interferes with the fluoride determination.

29. Why is fluoridation called an additive treatment? It is called an additive treatment because it is the only chemical intended to be delivered to the consumer. All other chemicals are intended to remove or modify some other constituent of the water.

Determinations and Tests

30. Does water have a fluoride demand? So far as is known, water has no fluoride demand. The full amount of fluoride added will show up in the distribution system. In hard water areas, however, a precipitation may occur at the injection point, due to the relative insolubility of CaF_2 and MgF_2.

31. How is fluoride in water determined? Fluorides are usually determined by the modified method of Scott—the addition of Zirconium Alizarin solution to form fluoride salt. Commercial apparatus uses the LaMar procedure with zirconyl nitrate. Interferences are about the same.

32. How is sodium silico fluoride determined? The same colorimetic method as used for sodium fluoride is employed.

33. Is the usual method of fluoride determination sufficiently accurate for control? Close checking by several State Boards of Health on results obtained by water plant operators have shown these to be remarkably consistent and accurate. Some states permit fluoride installations where chemists are not employed. Other states require a class B operator's license.

Installation and Cost

34. How much does fluoridation cost? The average annual cost of fluoridation is 10 cents per person, ranging from 5 to 25 cents, and depending on equipment and chemical used, and type of water system.

35. How much does fluoridation equipment cost? A suitable positive displacement feeder costs as little as $600.

36. How much space is required for a typical installation? A typical sodium fluoride installation, consisting of a saturator tank and positive displacement feeder, would require a space 2½ ft. square, plus access space.

37. Can sodium silico fluoride be fed as a solution? Sodium silico fluoride is a compound ordinarily having a solubility at 25°C of 0.77% or 0.0384 lb. of fluoride ion per gallon. For treating 1 mgd with 1.5 ppm, 330 gals. of solution will be required. Where this volume is not objectionable, it may be fed as a solution.

38. What precautions must be taken with sodium silico fluoride? The regular precautions usually taken against dust should be enforced.

39. What form of sodium fluoride is used in the saturator method? This method requires that the fluoride be in crystaline form. The 20-40 mesh, dust-free may be used, but 10-20 mesh is even more desirable.

40. What equipment is required for sodium silico slurry feeding? Slurry feeding requires a special tank with a baffled outlet, scales and feeder designed to handle a slurry.

41. Can a fluoride feeder be used for hypochlorination? The chemical feeder for sodium fluoride is of standard design and requires no changes for the application of hypochlorites. Because of the interference of chlorine with the fluoride determination, the dual application of hypochlorite and fluoride as one solution is not recommended.

Other Factors

42. Is the silicon content of sodium silico fluoride detrimental? In certain hard water areas where the silicon content of the water is critical, the additional amount of silicon may cause hard scale formation in power plants. The application of 1.5 ppm of fluoride ion by sodium silico fluoride will add 0.22 ppm of silicon.

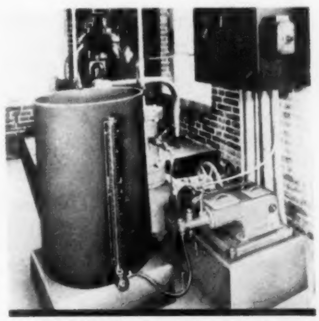
43. Can fluoride and chlorine be applied at the same time? This is not recommended because of the interference of chlorine with the fluoride determination. This interference can be removed by neutralizing the free chlorine residual with thiosulfate and then determining the fluoride content.

44. Do any other compounds interfere with the fluoride determination? The colorimetric determination of fluoride is the modified Scott method, as outlined in Standard Methods. The compounds that interfere with this procedure will interfere with any fluoride determination.

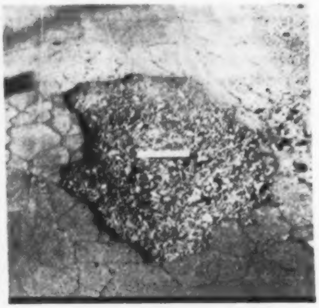
45. What effect will fluorides have on existing equipment? Trials and tests now under way must provide the answer. Fluoride may accelerate the dissolution of silica from zeolites.

46. What cities are now practicing fluoridation? More than 30 cities are now practicing artificial fluoridation. Among them are Marshall, Texas; Madison and Ft. Atkinson, Wisc.; Lewiston, Idaho; and Newburgh, N. Y.

47. What is the general opinion of public health officials regarding the fluoridation program? While desiring to be sure, through comprehensive tests, that there are no serious disadvantages, the opinion of some State Health Departments is that the benefits are very great.



● ***SODIUM fluoride solution is applied under 150-pound pressure.***



HOW TO PATCH

PATCHING holes in pavements is one of the essential jobs in maintenance. How to patch holes, using tar, is described in a Tarvia booklet, just issued, from which the following data are taken. The entire booklet will be sent on request to the editor of this magazine.

In preparation for patching, the holes should be cleaned carefully, removing all dust, dirt and loose material. The edges of the hole should be trimmed vertical. Cold patches are made with Tarvia KP, or Tarvia-lithic bituminous concrete; and hot patches with Tarvia X.

Patching with Tarvia KP

No hard and fast rules for proportioning the ingredients of the mix can be given, since aggregates vary greatly in quality and grading. In general, a soft stone, such as some limestones, will require more tar than a hard stone like trap rock. Also an aggregate grading which includes a large percentage of fine material will require more tar than one composed of uniformly sized particles. Sufficient tar must be used to coat thoroughly all of the aggregate, but not sufficient to run off the stone when the mix is placed in piles. In general, from 14 to 16 gallons of KP to a cubic yard of stone will be correct. If slag is used, from 18 to 20 gallons will be required. Too much tar will permit the patch to push out of shape under traffic, while too little will result in a patch which will ravel. Too little is better than too much, however, since the difficulty can be corrected by a seal coat.

No. 68 (¾" to No. 8) aggregate should be used for patching. With hard stone, such as trap rock, it is necessary to add from ten to twenty per cent of fine aggregate partially to fill the voids. This is not essential with a softer stone, such as limestone, where breaking occurs during the mixing and handling operations.

The top size of the aggregate may be reduced to one inch, or less, for patching shallow holes.

For mixing, the aggregate should be clean and dry. In cold weather, heating the aggregate to not over 100° F will assist in the mixing.

Best results are obtained by the use of a mechanical mixer. Any ordinary concrete mixer can be used satisfactorily. Coarse aggregate, tar and fine aggregate should be placed in the mixer in the order named. The mixer should be loaded to only about eighty per cent of its rated capacity for cement concrete. The mixing should be continued until all of the aggregate is coated with tar, which will usually require about two minutes.

Mixing can be done by turning the aggregate and tar with hand shovels. The aggregate should be placed on a mixing board, and the proper amount of tar poured over it in one or more applications. The mixture should be turned two or three times. If fine aggregate is used,

● ***HOLES should be cleaned and the edges trimmed vertical. Use slightly more mix than is necessary to fill.***

● ***ON LARGER patches, the repair material should be spread with rakes to insure even density over the entire area.***

HOLES IN PAVEMENTS

● ***AGGREGATE for patching should be ¾-in. to No. 8 mechanically mixed, with all particles coated.***

it should be added at this time. Turning and mixing should then be resumed and continued until all of the aggregate is thoroughly coated. This may require five or six complete turnings.

The mixed material may be used immediately, although it will be somewhat tougher if permitted to cure in a pile for a few days before it is used. The mix can be stored in piles for several months and still be in good condition.

Painting and Patching Procedure

The sides and edges of the hole should be painted with a light coat of Tarvia KP. This bonds the patch to the pavement and waterproofs the joint.

The mix should be placed in the hole using slightly more than sufficient to fill the hole. Too little is better than too much, since too much will cause a hump. Patches which are too low can be brought up by paint patching.

The patch should be well consolidated by tamping or rolling.

If the road being patched is to be surface treated, it will not be necessary to seal the patches. Otherwise, all but the most temporary patches should have a seal coat. It is good practice to leave the patch under traffic for several weeks, and then, after cleaning the surface, apply a light seal coat of KP with a brush or broom. The seal coat should be covered with coarse sand, stone or slag chips or pea gravel.

Small, shallow breaks in a road surface may be repaired, thoroughly cleaning the abraded surface, painting with KP tar, and covering lightly with stone or slag chips, or pea gravel.

Tarvia-lithic bituminous concrete is made in a central mixing plant and delivered ready for use. It is usually furnished in two sizes: the large, or bottom course size; and the fine, or top course, a mixture of stone chips, filler and a special tar binder.

Patching with Tarvia-Lithic

Holes one inch or less in depth may be patched with the fine size only. Holes deeper than one inch should be patched with a bottom layer of the large size, and a covering layer of the fine size.

For the deeper holes, the bottom layer of large size Tarvia-lithic should be placed in the hole, and tamped or rolled in place. A space about one inch deep should be left for the top course. The layer of fine mix should then be spread over the consolidated bottom course, so as to fill the hole completely.

Shallow holes are repaired by filling the hole with fine mix.

The patch should be thoroughly tamped or rolled into place.

Tarvia X is a tar binder delivered in drums (or in tank trucks in some areas). It does not require excessive heating and is used with ordinary maintenance equipment.

If the hole to be patched is more than two inches in depth, it should be filled to within two inches of the top with two-inch broken aggregate, tamped in place, and the voids filled with sand or stone screenings.

A layer of 1½" broken aggregate should be placed so as to slightly more than fill the hole. This should be tamped or rolled lightly.

Tarvia X should be poured into the broken stone at the rate of one-half gallon per square yard per inch of depth of stone. The patch should then be covered with one-half inch stone or slag chips, or pea gravel to fill the surface voids. Finally the patch should be sealed with the hot Tarvia X at the rate of one-half gallon per square yard, and covered with stone or slag chips, or pea gravel. The covering material should be rolled or tamped well to assure proper consolidation.

● ***PATCHES should be well consolidated, using a roller that is in good condition, either 3-wheel or tandem.***

DESIGNING SEWERS FOR THE SUB-ARCTIC

This article is based on an article by James R. Wilcox, City Engineer of Fairbanks, Alaska, which appeared in the "News Letter" of the American Public Works Association, and is limited to the design features that he has found, by experience, to be of value. It is believed that the design data given will apply generally to arctic as well as to sub-arctic conditions.

● ***IN THE far north, Walter Tiedeman and your editor sample arctic conditions. Permafrost and ten months of winter offer construction problems.***

SEWERS were installed in Fairbanks in 1939. Much trouble has been encountered during, and as a result of, the cold weather that occurs every winter. Tempratures drop as low as 60° below zero. The mean annual temperature is 26.1° F. The city is underlain with permafrost, or permanently frozen ground, over much of its area, and it is these sections that give the most trouble. The sewer system is being reconstructed over a four-year period to reduce the annual maintenance costs of $30,000 to $50,000. The special design principles to be applied in reconstruction, and which it is hoped will materially reduce freezing will include the following:

First, sewers will not be laid in or near the center of the street if it can be avoided. The reduction in the bearing capacity of the soil during the spring thaw, when the moisture content of the soil is the highest, permits consolidation of the roadbed under traffic, and this in turn adversely affects sewer alinement. Where possible, the sewers will be laid along the interior lot lines, along the inside edge of the sidewalk, or in the gutters. These locations give additional protection against frost penetration because of the undisturbed insulating blanket of snow.

Trouble With Permafrost

Second, sewers should not be laid directly on permafrost. Where permafrost is encountered, the ground should be thawed for a minimum depth of 2 feet below the proposed invert and replaced with well compacted gravel that will permit drainage. This construction tends to insulate the permafrost from the heat given out by the sewer and will help stabilize the subgrade.

Third, sewers should not be laid in frost-susceptible soil. Experiments have indicated that during freezing of fine-grained soils, water flows to the freezing layers by capillary action from the water table below. This increases the water content of the soil and causes heaving under the action of seasonal frost.

Fourth, minimum pipe size should be 8-inch. Observations on operative sewer lines of 8-inch and larger size indicate that cone-shaped frost accumulations build up along the horizontal axis of the pipe. Normal fluctuations in sewage flow cause this area to be wetted periodically. As soon as the flow decreases, the moisture that is left freezes, further building up the cones. Evidently, these cones do not have sufficient adherence to the walls of the sewers to remain long enough to close an 8-inch line; but they will build up enough to close smaller sizes of pipe.

Fifth, all pipe should be of wood staves. Such pipe has superior insulating qualities; and, in addition, the pipe has enough elasticity to resist permanent deformation or breakage. Composition pipe, impregnated with asphalt, will resist a certain amount of deformation due to freezing, but if steam is used for thawing out the line after freezing, the asphalt is melted and the pipe collapses.

House Vents

A question still unanswered is the influence house vents have on the freezing of sewers. The natural flow of cold air through a sewer caused by a warm house next to a cold one, or a tall building next to a low building, could have a material bearing on the freezing of sewers. A control on vent-stack openings would be one answer to this problem. Another so far unanswered question is the influence that ground temperature has on the freezing of sewers, and the advisability of insulating the sewers with sawdust, slabs or other locally available material. Experiments are now under way to determine the influence of insulation and the variation of ground temperatures in relation to temperatures inside the sewers. Thermocouples have been installed to record temperatures below and on both sides of the sewer, and on the inside at the top and at the invert.

It has been shown that sewer design standards acceptable in the "states" are entirely inadequate in an area underlaid with permafrost. During the peak of the sewer-freezing season—February and March—over one-third of the area in Fairbanks that is serviced by sewers is without disposal facilities. The sewers are frozen. Sewer maintenance then consists of steaming the ice from the sewers, using steam at 100 to 125 pounds pressure. This method is slow and costly—as much as $2.40 per foot on the badly frozen lines.

Only a limited amount of rehabilitation was attempted last year, as all of the work was frankly experimental. Of the 4,715 ft. of laterals partly rehabilitated, three laterals with a total length of 1,556 ft. froze at least once during the past winter. None of the relaid or relocated lines froze.

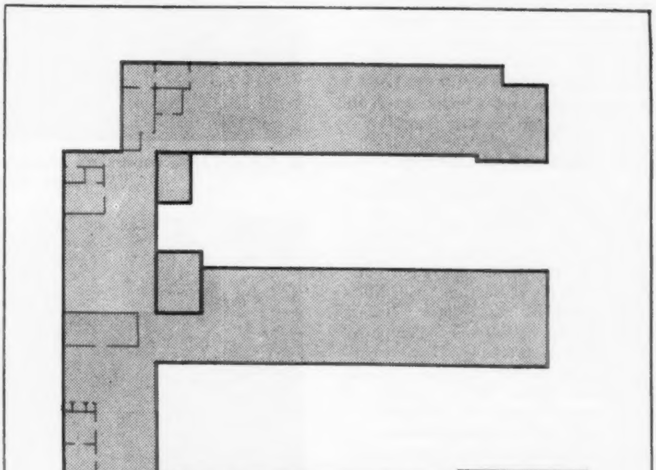
ADMINISTRATION BUILDING for STATE HIGHWAY DEPARTMENT

G. ALBERT HILL

State Highway Commissioner

THE Connecticut Highway Department's new District No. 3, Administration Building, long a needed facility, is the result of planning begun as early as 1947. The building is located on Pond Lily Avenue, New Haven, adjacent to the Wilbur Cross Parkway to which appropriate exit and entrance ramps provide easy access between parkway and building.

Previously, engineering and maintenance forces and equipment in the New Haven area were housed in several rented structures. These were totally inadequate for the number of employees and pieces of equipment required to use them. Some of the complement of trucks and cars were stored outside the year around. Facing the necessity of creating and housing additional parkway maintenance forces, a new building became a must. In addition to getting all of the area's personnel and equipment housed under one roof, a saving in the cost of rental, heating and lighting was a positive accomplishment.



● *FLOOR plan of the new District No. 3 Administration building which houses district personnel and equipment.*

The total cost of this new building was slightly less than $500,000. Floor space is 42,275 sq. ft., of which 32,211 sq. ft. comprise the ground floor. Modern design and equipment were used throughout.

Building Details

The new structure, which was designed by Frederick J. Dixon of Bridgeport, has a frontage of 239 feet. Three wings extend back for a length of 189 feet each to form the shape of the letter "E". The building is two stories, of 12-inch exterior walls with Clerespan and open-web steel floor and roof joists. It has concrete for the ground floor and asphalt tile on concrete on the second floor. There is no basement.

The building has a total area of 42,275 square feet of which 32,211 square feet is occupied by the ground floor. On this lower floor storage space is provided for 34 passenger cars and survey trucks and 28 maintenance trucks. There is also space for a lubricating room, carwash room and a shop for making minor repairs to equipment. In addition, stalls are provided for the storage of materials and small tools.

The second-floor wings are occupied by the engineering forces of the former New Haven Residency. The offices and drafting rooms on this floor have lath and plaster walls and acoustic ceilings. Locker rooms, toilets and a map-file room are also located on this floor.

Heating and Lighting

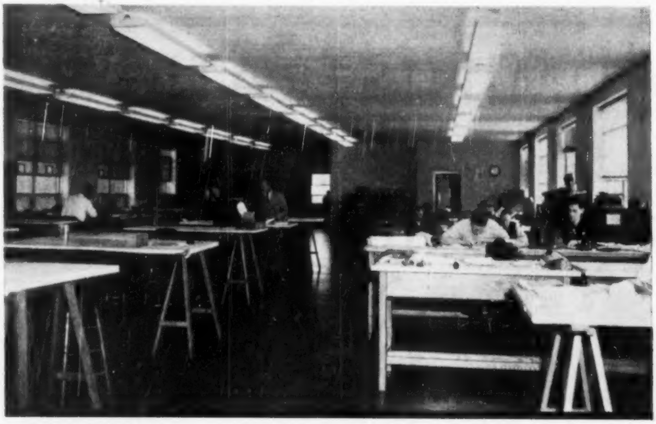
The building is heated by radiant heat and radiation by the use of radiant heat coils in the first-floor concrete and radiators on the upper floor. The heating system consists of two, 12-section, 440 Mills low pressure hot water boilers equipped for oil burners. Temperature controls for the radiant heating system and for the office radiant convector system is by means of Sarcotherm which is designed to recirculate a varying portion of returned water to the radiators and coils. The proportion of generated water temperature to returned water temperature is controlled by a Sarcotherm, thermostatic, three-way valve for each of the two systems.

This three-way valve is arranged for circulation of tempered water through the system and is controlled by (1) an outdoor bulb sensitive to wind velocity and radiation activity and (2) the mixed water temperature flowing through the valve. The indoor temperature can also be set manually by means of thermostats located in strategic parts of the building.

The building is lighted by Slimline fluorescent fixtures on the second floor and incandescent lamps on the ground floor. Switch arrangements permit the turning off of alternate lights or lights in banks. The telephone switchboard, located on the upper floor has five dial-phone trunk lines coming into it. During the day all calls to the building are routed through the board. At night calls may be made to the building by dialing specific numbers. The system permits any member of the personnel to dial any telephone in the building without going through the switchboard.

The structure was erected by the E. and F. Construction Co. of Bridgeport and the Site Improvement contract was performed by the C. L. Hale Construction Co. of Manchester. The total cost of building and site improvement amounted to slightly less than $500,000.

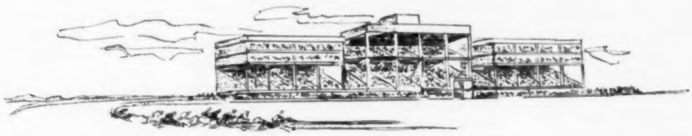
This building is now headquarters for highway engineering and maintenance functions in south-central Connecticut.



● ***DRAFTING** rooms on the second floor have acoustic ceilings and Slimline fluorescent lighting*

● ***RADIANT** heat coils in the first floor concrete make undercarriage repair work more pleasant.*

Standards and Design Data for OUTDOOR GRANDSTANDS



These data are from Bulletin NFPA, No. 102 National Fire Protection Association, the standards in which were adopted by the Building Officials Conference of America, National Fire Protection Association and National Board of Fire Underwriters and have been submitted for approval to the American Standards Association.

DEFINITIONS of terms used include: A "grandstand" is any structure intended primarily to support persons for purposes of assembly, but this does not apply to the permanent seating in churches, theaters, auditoriums and similar buildings. "Places of outdoor assembly" means premises used, or intended to be used, for outdoor public gatherings of 200 or more persons. A "portable grandstand" is an assembly of prefabricated units, readily erected, dismounted or transported, and used for movable or temporary supports. The term "sectional benches" means seating benches made up for assembly in sections not to exceed 10 rows and not to exceed 100 seat spaces per section, the uppermost seats being not more than 4 ft. above ground or floor level.

The capacity of any structure or enclosure for outdoor assembly shall be the number of fixed seats, plus an allowance of one person for each 6 square feet of floor or ground area designated as standing space or for movable seats. A distance of 18 ins. along any undivided bench or platform constitutes one seat in computing capacity. The floor area of stairways, ramps, aisles, passageways, etc., within such structures or enclosures shall not be considered in computing capacity and shall not be used for either seats or standing room.

Design Standards

The following standards for materials and equipment applies in design, fabrication and construction: Concrete, American Standard Building Code Requirements for Reinforced Concrete, ACI 318 and ASA A89.1. Masonry, American Standard Building Code Requirements for Masonry, ASA A41.1. Steel, Am. Standard Building Code Requirements for Structural Steel, ASA A57.1; American Iron and Steel Institute specifications for the Design of Light Gage Structural Members; Tentative specifications for Hot Rolled Strip of Structural Quality, ASTM A303; and Standard Specifications for Black and Hot-Dipped zinc-coated (Galvanized) Welded and Seamless Steel Pipe for Ordinary Uses, ASTM A120. Wood, National Design Specifications for stress-grade lumber and its Fastening, National Lumber Mfrs. Assn.; and Wood Handbook, Forest Products Laboratory, USDA. Means of egress, Building Exits Code, National Fire Protection Assn., ASA A9.1. Electric Wiring and Apparatus, National Electrical Code, ASA, C1. Elevators and Moving Stairways, American Safety Code for Elevators. Dumbwaiters and Escalators, ASA A17.1.

Location, Size and Seats

An outdoor wood grandstand should not be closer than 10 ft. or 2/3 of its height, which ever is greater, from a building which is of less than one hour fire resistance, with protected openings, unless a fire resistant wall is interposed between them.

A wood grandstand unit should not be more than 200 ft. long or have a ground area of more than 10,000 sq. ft. Units must be separated by 20 ft. or by walls of one-hour fire resistance. Not more than three units should be erected in one group, and groups must be separated by 50 ft. of open space, a wall of 2 hrs. fire resistance 2 ft. higher than the seat platforms, or certain types of non-combustible construction. If grandstand units are of flame resistive wood, treated properly, permitted areas and lengths may be doubled.

The highest level of seat platforms on a wood grandstand should not exceed 20 feet.

Two or more avenues of departure should be available for all but very small places. Where possible, these should lead to separate streets or roads; otherwise there should be free and ample access to the single road or street from the remoter parts of the grandstand, and these should be kept clear at all times These requirements may be a factor in location.

Loadings for Design

Grandstands should be designed to support, in addition to their own weight, a uniformly distributed live load of 100 pounds per sq. ft. of gross horizontal projection of the stands. All seats and footboard members should be designed for live loads of not less than 120 pounds per linear foot.

The design should be such as to resist, either with or without live load, a horizontal wind load of 30

pounds per sq. ft. on all vertical projections of the stand.

Grandstands should be designed to resist a horizontal swaying force applied to the seats in a direction parallel to the length of the seats of 24 pounds per linear ft. of seats: and in a direction perpendicular to the length of the seats of 10 lbs. per linear foot of seats.

The design should be examined to insure that members in which stresses are greater under a partial loading condition shall be designed to meet the conditions causing the largest stress. Also, the design and assembly should be such that maximum expansion, contraction, settlement or misalinement that may be likely to occur will not cause stresses in excess of those permissible. The design should be checked for overturning by unequal distribution of live load, or by wind under all conditions.

Aisles and Seating

When a grandstand has seats with backs or a railing or guard along the front, aisles shall be so located that there is no row of more than 16 seats. Aisles must be at least 40 ins. clear width; except in an open bleacher-type stand they may not be less than 36 ins. wide; and when an aisle serves not more than 60 seats it may be 24 ins. clear width. Where an aisle is divided by a column or other obstruction, each part must have a width of at least 24 ins. Ramps leading to aisles must be as wide as the aisle.

Steps should not be placed in aisles unless the rise exceeds 1 ft. in 10 ft. When the rise of the seating platform exceeds 11 ins. an intermediate step must be provided the full width of the aisle and so proportioned as to provide two steps of equal rise for platform. When the rise exceeds 18 ins. there must be three steps so proportioned.

The usual line of travel from any seat to the nearest exit on the seating area cannot be greater than 150 feet.

The horizontal distance, back to back of seats, must not be less than 30 ins. for seats having backrests, nor less than 22 ins. for bleacher type seats. Where the same level is used for both seats and footrests, these levels must be at least 22 ins. wide. Between the back of each seat and the front of the seat directly behind it there must be a horizontal distance of not less than 12 ins. The width of footboards (footrests) in grandstands must be at least 9½ ins. and the width of seatboards at least 7½ ins. Bleacher type seats and footrests of grandstands must be securely supported and fastened in place. Where footrests are lapped, positive means for preventing displacement is required. Individual seats and chairs must be firmly secured in place, except in railed-in enclosures on the floor level.

Railings and Guards

Where seats are more than 4 ft. above the ground, railings or guards at least 42 ins. high above the aisle surface or platform head must be provided. Where the front footrest of the stand is more than 2 ft. above ground, railings or guards at least 33 ins. high above such footrests must be provided. Openings between the top railing or guard and the walkway surface below, if more than 18 ins. high, must be not more than 11 ins. wide.

Railings or guards must be capable of sustaining a vertical load of 100 pounds per linear foot and a horizonal thrust of 50 pounds per linear foot.

Railings and guards may be omitted from the portions of a grandstand which are adjacent to a wall or fence affording an equivalent safeguard.

Exits

There must be at least two exits from a grandstand, as remote from each other as is practicable, and these must lead directly to the outside. If the capacity of a balcony or tier or of the structure exceeds 1,000, there must be at least three exits; and if the capacity exceeds 4,000, there must be at least four exits.

A fenced place of outdoor assembly must have at least two exits; if more than 6,000 persons are to be accommodated, there must be at least three exits; and if the capacity is greater than 9,000 there must be four exits.

The line of travel to an exit or to the entrance to an exitway must not be greater than 150 ft. The aggregate clear width of doorways, stairs or ramps serving as exits from structures used as places of outdoor assembly is determined by providing at least one unit of 22 ins. width for each 100 persons to be accommodated; except that in bleacher type grandstands without canopy, cover or roof, aggregate width may not be less than 22 ins. for each 500 persons.

Doorways serving as exits from stairways, ramps or passageways must be at least 36 ins. clear width; and must be not less than 2 ins. narrower for each unit of width than the exit-way it serves. In general stairways and ramps must have a width of at least 44 ins. Exits, aisles and passageways must be adequately lighted whenever the structure is occupied.

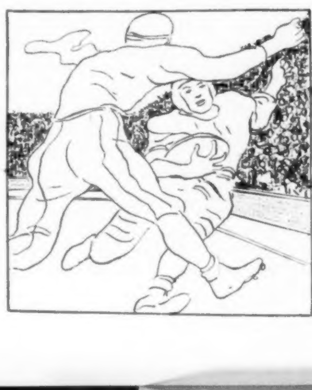
The requirement that the line of travel to an exit or the entrance to an exit shall not exceed 150 ft. does not mean that it is necessary to reach the ground or street by traveling this distance. Some designers believe that exitway capacities should be such that capacities of neighboring streets are not exceeded. The building exits code provides that the aggregate width of exits from places of public assembly shall not exceed 80% of the width of public ways into which they discharge.

Sanitation and Safety

The rules of the Health Department, State or Local, should govern the arrangements and facilities for preparing and serving food and other refreshments; the collection and disposal of garbage; the supplying of water for drinking or other domestic use; and the provision of toilet facilities.

Fire extinguishing equipment should be provided on the following minimum basis: One 2½-gal. class A extinguisher in every assemblage unit having a flow area of more than 500 sq. ft., but less than 1,000 sq. ft.; and one such additional extinguisher for each 2,000 additional sq. ft. or fraction thereof. Also, one 1-qt. vaporizing liquid or one 4-pound CO_2 extinguisher for each power generator or transformer; also, one 2½-gal. foam or 2 1-qt. vaporizing liquid or one 12-pound CO_2 or dry chemical extinguisher in each kitchen or other areas where flammable grease or liquids are used, stored or dispensed.

Editor's Note: The complete booklet is available for 25¢ from the National Fire Protection Assn., Boston, Mass.



HOUSTON USES ELECTRIC LOG ON NEW WELLS

From the annual report of
CLYDE R. HARVILL,
Sanitary Engineer,
Water Dep't., Houston, Tex.

THE outstanding activity of the Sanitary Engineering Section of the Houston, Tex., Water Dept. in 1949 was occasioned by the extensive expansion of the supply well fields. During the year there were 18 wells under contract; 10 of these have been completed, 4 are under construction and 4 remain to be drilled. Also featured during the year was an unusually large number of chlorination jobs.

Every effort was made to obtain adequate and reliable test information during the construction of the new wells. Personnel were in attendance on the rig, without regard to time or weather, to carry out the various electrical surveys and to supervise all drill stem testing on the wells. Laboratory schedules were arranged and re-arranged to accommodate the samples from drill stem tests, production tests, and sand analyses. The chlorination crew worked on a 24-hour schedule in chlorinating the gravel for gravel-walling the wells and for chlorinating the several well collection lines.

Using the Electric Log

From this activity, several developments in water well construction were noteworthy. In the early part of the drilling program we experienced some difficulty in obtaining a water sample satisfactory for chemical analysis by drill stem testing. To meet this problem, the use of a caliper survey, run immediately after the electric log, was instituted. A caliper survey shows the actual diameter of the drilled hole and clearly demarks areas of caving. The use of this survey resulted in approximately a 30% reduction of drill stem test failures—it took the guesswork out of selecting the proper size packer to seal off the formation and it allowed the selection of a formation sufficiently hard to hold the packer of the drill stem testing tool. The water samples obtained after instituting this survey contained much less contamination from drilling mud and grease and were almost uniformly satisfactory for analysis.

A total of 42 complete chemical analyses were made on drill stem test samples during the year. These analyses give a good picture of the characteristics of the water encountered at various depths and were of material aid in determining screen settings. They also allowed a complete demarcation of salt water formations in our several well fields. Complete chemical analyses were also made on the water obtained from production tests on the 10 completed wells, and these analyses show that we have been able to construct wells to produce water with a hardness of less than 50 ppm except in 2 instances, where hardnesses of 61 and 76 ppm were obtained.

Three wells under construction were temperature surveyed during the year. Careful study of these surveys revealed no information not discernible from the electric log or caliper survey and the temperature survey was discontinued.

A totally new development, recently employed, was a caliper survey of the underreamed hole. To our knowledge, we are the first organization to encourage the well logging corporation to design and build a tool capable of measuring a 30" hole; or, in other words, for the first time in our history, we have a survey available which verifies the underreaming, an important part of water well construction. The "big" caliper survey was used on the last 4 wells drilled. One well was surveyed by the logging corporation on an experimental basis, at no cost to the Water Division, and 3 wells were surveyed on a contract basis. Surprisingly, the information obtained more than paid for the cost of the surveys. In each instance the underreaming had not been completed as directed and we were able to avoid setting screen in an improperly underreamed hole.

The well drilling program was by no means completed in 1949. A total of 8 wells remained under contract and of the 10 wells completed only 3 had been turned into the system. Correspondingly, this Section's work on the wells was not completed. The job of assembling, studying, and tabulating the test data was kept abreast the drilling work, but final correlation of the information on hand and the information to be obtained must await the completion of all 18 wells.

Chlorination Work

It is estimated there were not more than 10 days of the year when the mobile chlorination units were idle. The well drilling program accounted for chlorinating the gravel for gravel-walling 10 wells, chlorinating these walls after the pumps had been set, and chlorinating the 47,431 feet of well collection lines. Several subdivisions and private systems required chlorination service. In all 135 miles of mains were chlorinated during 1949.

Treatment Control

Major expansion of the plant facilities to care for the increased well production was begun during the year. Completely new plants for the Heights and North East areas were under construction and a new chlorination building for the Stand-By Plant was completed. Each of these new installations included specifications for the latest type au-

(Please turn to page 91)

PLANNING THE SEWAGE LABORATORY

EARL BENNING

NEVER in its lifetime does a sewage plant cause more headaches than during its first year of operation. The personnel, with rare exceptions, has had no more than theoretical training for the job. From the first day, sludge inexorably keeps accumulating and starts acting up before the proper pumping cycle can be established by trial and error. The first million cubic feet of gas, contaminated with hydrogen sulfide and mercaptans, has no other place to go but up into the atmosphere because it won't burn yet. Residents of the vicinity harass the management with angry complaints about odors which are often imaginary but just the same require investigation and reports to the authorities.

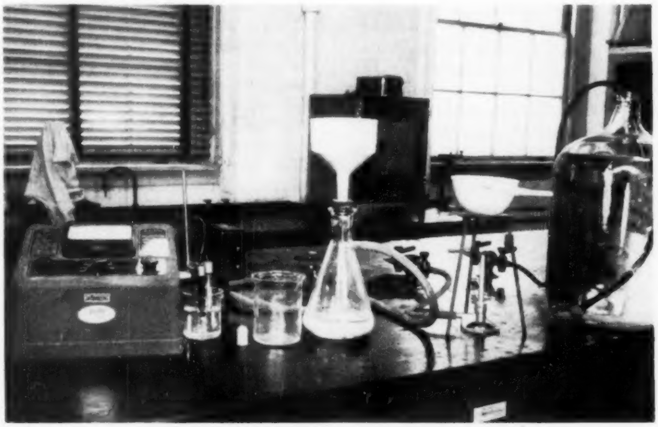
That is the time when the control laboratory has to justify its existence if ever. But is it ready? More often it is not, and if the reasons for this are recognized and anticipated, most of the nights when managers' hair turns prematurely gray need never to happen.

The Chemist Needs His Tools

It doesn't help any to blame it all on the incompetence of the chemist when he can't pop out the lucky answers at a minute's notice. What would you expect from a carpenter without hammer and saw? The chemist needs his tools just as much. But was he around, or did anybody ask him, when the blueprints of the designing engineer were approved a year or more before? So the best he can do is to try to work with what he finds, which is what the plant designer thought best by his lights. He, in turn, put his faith in a list of equipment in his handbook. That list may have been reprinted time and again verbatim from obsolete editions but perhaps had been just the right thing in the lifetime of the original compiler.

But as time marches on, newer and better methods are developed every year, and newer and better equipment is put on the market. Much of what was ordered too soon and knocked around in contractors' toolsheds is damaged if not ruined by the time it is put up in the laboratory.

The reward for past mistakes of this kind is this lesson: Don't try to anticipate every last detail. True, it is a matter of great pride for the engineer to promise a plant "complete and ready for operation." But why stick your neck out for others? Give the chemist a chance to make his own mistakes. Set aside a reasonable portion of the appropriations in a lump sum for laboratory equipment, glassware and reagents. Then advise your client to call in the chemist a month or two (or more) before opening date, and make it his duty to have the laboratory organized and ready for action at the first signs of trouble.



• CENTRAL utilities outlet on laboratory bench, showing 110-V AC, vacuum, gas and compressed air readily at hand.

The engineer's responsibility will still be formidable: the basic layout, all the things that can't be changed once they are down in brick and concrete, and the installed immobile equipment.

For reasons more apparent to the man who works in the laboratory you build for him, it should be laid out with all its windows facing north. Otherwise, with sunlight continuously changing direction and in-

tensity, color reactions such as for residual chlorine are difficult to duplicate at different times of day.

For the same reason, artificial lighting should match north light in neutrality and direction. The closest approach to this ideal would be tubular fixtures parallel to the ceiling cove above the windows. If these fixtures are indirect and reflect from a slick, white plaster ceiling, the room will be flooded with a neutral, uniform and shadowless light which, incidentally, is polarized, free of glare and easy on the eyes, particularly with incandescent lamps. Fluorescent light irritates some people's eyes, probably because of leaks of ultraviolet and flickering.

The Work Bench

The natural place for the single workbench which the average sewage plant laboratory needs is along the wall under the windows. For this arrangement, the conventional lighting fixtures, suspended from the center of the ceiling, are easily the least useful, as they force the chemist to do his bench work in his own shadow.

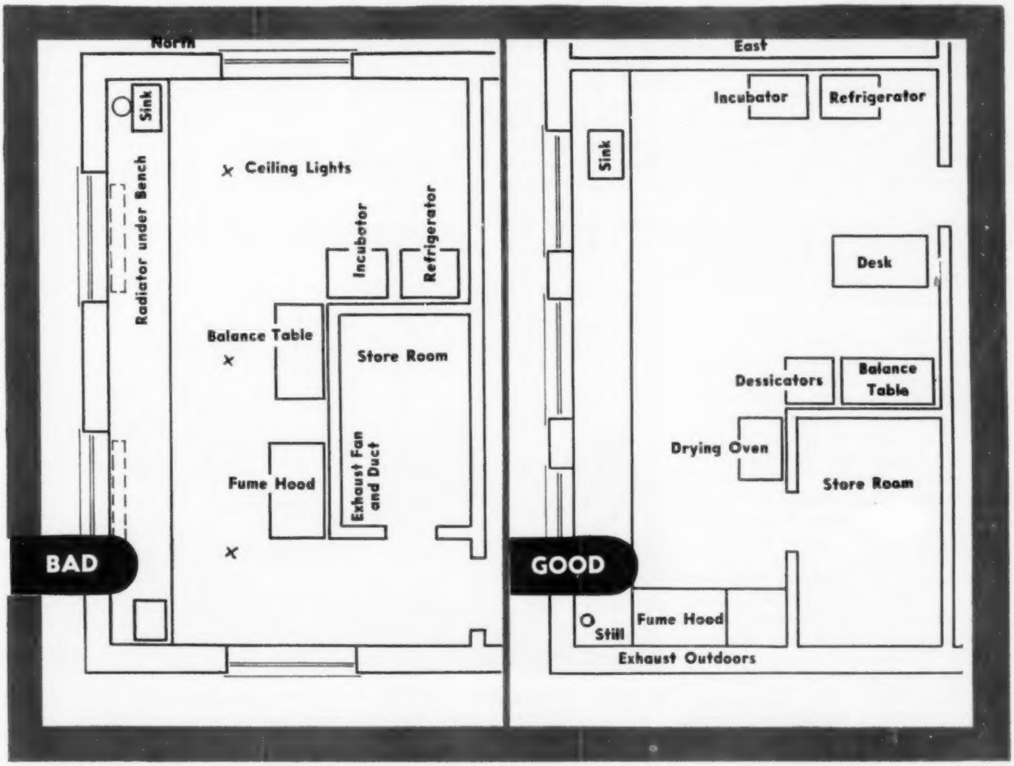
Stone tops on laboratory benches have been responsible for the premature death of untold carloads of glassware. But wood is tough, resilient, and kind to bouncing glass. It can be cut and drilled after it is installed, so it does not force the planner to decide far in advance on a definite arrangement of utility outlets. Ordered unfinished, the wood top may be inspected for flaws before acceptance.

Behind the misnomer "carbonized wood" hides the age-old aniline black, which is not a finish in the sense that it protects the wood. It is merely dyed black by a succession of chemicals dissolved in water. An excess of aniline remains which is quite toxic and must be removed by generous applications of soapsuds. All this wet treatment on one face can hardly fail to warp the wood; it will keep on warping until coated with drying oil or varnish suitable for the purpose.

A much simpler and more satisfactory finish is asphalt varnish, with a guaranteed content of genuine natural asphalt. For the first coat, the asphalt varnish should be thinned with turpentine for deeper penetration. Several coats, which dry rather fast, bring out the desired depth of color. Natural asphalt becomes quite insoluble and inert to most chemicals after exposure to daylight for some length of time.

Do not install radiators under, or close to, the bench. The heat rising from them would spoil reagents which must be kept at hand on the bench.

In some laboratories, the utility outlets are distributed with broadminded impartiality: a water faucet here, a gas cock ten feet away, and an electric outlet somewhere else again. It often exhausts the available supply of rubber hose to bring them all together for one operation, say, a distillation of volatile acids.



● ***THESE two layouts occupy the same space. Some of the advantages of the arrangement at the right can be seen from inspection. For discussion of other points and equipment needs, see the text.***

Much more leeway for convenient arrangement later on is left if all utilities are brought in under the bench somewhere nearest the mains, and then carried along under the bench for its whole length. They may then be tapped alternately so that any or all of them are available within any four-foot section of the bench.

This also applies to waste disposal. Some prefabricated laboratory benches are furnished for this purpose with continuous troughs at the rear. Simpler and less expensive is a 2" pipe with T's inserted every four feet. The open center arms of the T's protrude upwards through holes in the benchtop, and liquids discarded into them flow through the pipe into the sink.

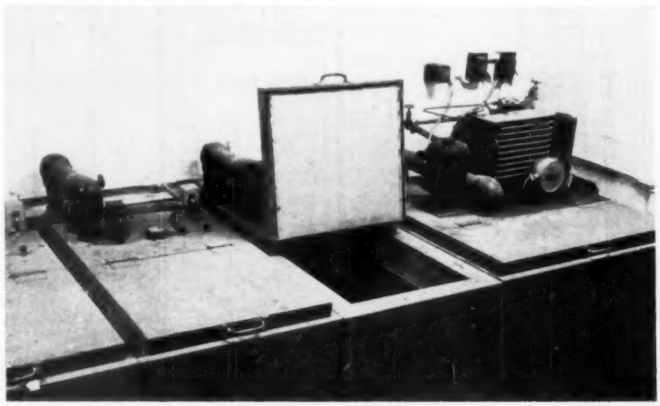
The Fume Hood

If the fume hood is installed adjacent to the bench, two advantages are gained. Firstly, steps and time are saved. Secondly, the utilities serving the bench can conveniently be extended to the hood. For there are very few uses for a fume hood which do not include a gas burner or an electric hotplate. Furthermore, any sewage laboratory may at some time in its many years of life face the necessity to analyze samples for nitrogen. The digestion of the sample by the official Kjeldahl method evolves heavy fumes of sulfuric acid which are very harmful and extremely corrosive to all materials, including brickwork, concrete and all common metals except lead. These fumes therefore must be made harmless before they leave the hood. This requires a generous supply of flowing water for scrubbing by means of an aspirator and, of course, a waste outlet of lead pipe.

For efficiency of the aspirator, the water pressure should be unobstructed. This means at least a ½-inch pipe and no 90° L's. The best is an upright pipe of brass or bronze, gently curved in a half-circle at the upper end to the shape of an inverted J, the shorter, open end pointing straight down into the waste pipe. Most metal aspirators take ⅜" female pipe thread.

Safety and efficiency are enormously increased by a sliding, counterpoised front sash with wire-reinforced glass panels. Closed, the sash protects the chemist from injuries by violent reactions which may occur. Pulled down to leave a small crack, the sash intensifies the draft in inverse proportion to the size of the opening. In order to control a runaway reaction, it is often desirable to regulate a burner or heater from outside the closed hood. Therefore, the best place for valves and switches is the front panel directly below the table top of the hood.

The draft of the fume hood offers a challenge to the ingenuity of the designer of a digester plant. Before suitable electric exhaust fans became available, the draft was very efficiently produced by a "lure flame", a gas jet lighted in the chimney directly over the hood. As digester plants have an ample supply of gas and an excess to get rid of through the waste burner, part of the waste gas could be diverted to the chimney for a lure flame. An elegant layout of a digester plant would then place the laboratory where the wall with the hood installation is contingent with the plant chimney. This saves the cost of buying, installing, operating and maintaining an exhaust fan. Incidentally, the natural draft of the chimney alone would in most cases be sufficient for routine work, particularly in cases where an open flame should not be used, as for evaporation of ethers in fat determinations.



• ***MILK coolers used for BOD incubation are fitted with perforated shelves to hold samples. Thermostats control heat.***

The incubator serves in the sewage laboratory for keeping samples for BOD determinations constantly at 20° C. Therefore, a second incubator would be needed if bacteriological work is to be done, which requires higher temperatures. However, whether an incubator is indeed the best possible equipment for BOD tests may be questioned.

As is well known, a BOD sample becomes useless if only a tiny air-bubble gets inside the sample bottle. Specially designed BOD bottles prevent such accidents by means of a funnel-shaped collar in which water is kept during incubation. This small amount of water often dries up during the usual 5-day period. The bottles, therefore, must be frequently inspected and the water traps refilled.

A safer way is to keep the bottles totally submerged in a water tank; and in that case, it is not even necessary to use special BOD bottles, which are fairly expensive. This will be mentioned later on.

A water tank of heavy sheet copper may be fitted into the dry incubator, as large as space permits. It should be high enough to keep the bottles submerged, plus a margin for displacement. Shelves in the incubator must be removed to give access to the bottles from above.

This seems a somewhat roundabout way to a simpler and more elegant solution. The Department of Sanitary Engineering of the University of North Carolina incubates BOD samples in dairy milk coolers. These are rectangular, double-walled, well insulated tanks which open at the top like trunks. They are lined with sheet copper, and the U. of N. C. engineers had them fitted with perforated shelves of the same metal at the proper depth. The water is kept at constant level and temperature by feed and overflow tubes and by thermostats. The ease of access, and the safety from spoilage by accidental airleaks make these coolers appear decidedly preferable to dry incubators with doors opening in front.

Other Units

All that is to be demanded of a refrigerator is that it be spacious enough to hold at least all samples

(*Please turn to page* 56)

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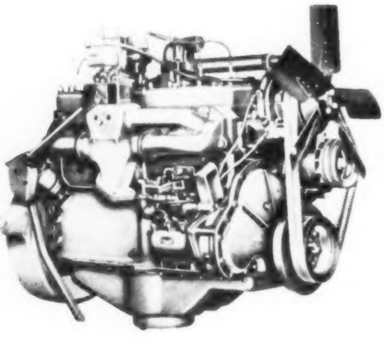

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Laboratory

(Continued from page 52)

taken during 60 hours, as over Sundays. The door should be so hinged that it gives convenient access in the planned location.

Instead of the conventional separate units of muffle, resistor and pyrometer, compact units comprising all three are now available. They can be set for the desired temperature in advance, use less space and save wiring and installation.

A water still of one gallon-per-hour capacity is quite sufficient. It should be installed close to the ceiling over the sink, so that the water is delivered into a 5-gallon bottle. This again is connected with a second 5-gallon bottle by a syphon tube to maintain equal levels in both. The water is then drawn for use from the second bottle where the water has already cooled to room temperature. Both bottles stand on a high shelf to give rapid gravity flow.

To keep bulk chemicals and pure reagents in unchanged condition in the store room, daylight should be kept out, and the temperature maintained reasonably constant and cool. Therefore, the walls should be insulated, and there should be no windows. Hot-water pipes, steam pipes, motors that generate heat, etc., must be strictly excluded. Freezing temperatures also are damaging to many chemicals.

Vacuum Pump

A high-vacuum pump has no place in the sewage laboratory. Not only does it serve less well than a sturdier pump, but it also loses its efficiency rapidly as water vapors are drawn into its oil chamber during filtration of aqueous solutions. An electrically driven, air-cooled combination blower and vacuum pump, which delivers at least 20 inches of vacuum, has several decided advantages over a high-vacuum pump. It costs considerably less, pumps more air in less time, is not sensitive to water vapors, and can be switched to deliver compressed air for a torch or a spray gun. Its noise will be minimized by mounting it in one of the coverts under the bench. It can then be connected permanently to stopcocks in line with the other utility outlets on the bench. The switch is installed on the front panel of the covert.

Drying Oven

Glassware, and samples which require no great accuracy, may be dried in the heat chamber which is often provided in the covert under the fume hood. Its efficiency is greatly increased by cutting rows of about 1" holes near top and bottom for air circulation. Samples which are to be weighed on the analytical balance must be dried in a regular drying oven which keeps the temperature constant above the boiling point of water. Much drying time is saved with an oven with forced circulation; without it, sludge samples may have to be kept in the oven over night to dry to constant weight.

Fire Extinguisher

Of the various types of fire extinguishers, only those with dry carbon dioxide are suited for the laboratory. Those of the foam type are undesirable because they leave a sticky, spongy residue which may ruin valuable apparatus and cause short circuits. The carbon tetrachloride type should never be used indoors at all; besides clouds of black, sooty smoke, it may generate phosgene, one of the poison gases.

Mobile Equipment

This much for the more important items of immobile equipment which it will be the task of the engineer to install. As for the mobile equipment, it is better left for the chemist himself to select. Whether or not that is possible to arrange, a few items deserve special attention.

Now that the Chainomatic patents have expired, a chainweight balance wins hands down over the obsolete rider balance. The premium on the price pays itself back several times over by the saving in weighing time alone. Without exaggeration this amounts to at least 80%. When the beam is notched for one full gram in tenths, no fractional weights are needed at all; this saves one-third of the price for a set of weights.

For general weighings, an excellent balance is the well-known Ohaus model with stainless steel pan and triple beams to which sliding weights are attached and cannot get lost. An extra tare beam increases its usefulness, and two auxiliary weights extend the range to over 2,000 grams. This outfit costs no more than a conventional trip scale plus weights.

As electric potentials are the prime standard for the definition of hydrogen concentration, a potentiometer pH machine with glass electrode is decidedly superior to other methods, which may be less sensitive, often leave room for

doubt, and require fairly translucent samples. Also, filtration, whenever necessary, may change the pH because of time consumed and volatile matter lost, while the glass electrode can be inserted in a fresh sludge sample without preparation and delay.

True, many an operator professes not to pay any attention to pH at all. That may be all right once he has become familiar with the characteristics of his particular plant, or has acquired wide experience. The less experienced operator of a new plant can be spared much uncertainty and anxiety if he knows he can rely on his pH control.

If provision is made to incubate the samples under water, as previously suggested, no special BOD bottles are needed. Common 8 to 10-ounce tincture bottles with well-fitting glass stoppers serve as well and cost much less. The thing to look for is narrow necks and short stoppers. They displace less liquid, and this means substantial savings on Winkler reagents, which are quite expensive. In addition, several 5-gallon bottles will be needed for storing and aging dilution water.

There should be at least one burette with automatic zero. The plain, muzzle-loading type is far too time-consuming for the daily chore of thiosulfate titrations.

Instead of putting the apparatus together from separate parts, a compact unit is on the market which is excellently suited for volatile acids. It is the Reichert-Meissl outfit which was originally designed for butter fat analysis.

The qualified chemist is familiar with most of the other regular laboratory equipment. Until the plant has passed the test of at least one full cycle of seasons, nobody can quite tell what may happen. Even after that, new problems are bound to turn up. In a growing community —and which isn't?—new industrial plants may be cut in on the sewage system and upset the balance of the treatment cycle. Laundry wastes, metal pickling solutions and the like may call for unscheduled analytical work. It will then take three things to be prepared for the unforeseen:

The chemist must know his stuff;

Time-saving devices and methods must keep to a minimum the hours and effort spent on daily routine chores, so as to leave extra time for extra problems; and

The engineer must have planned the laboratory flexible enough for expansion of its activities.

HYDRAULICS

This is one of a series of articles by the Editors of PUBLIC WORKS illustrating the methods of solving usual hydraulics problems without recourse to complicated mathematical formulas. Also these articles cover basic hydraulic data and show how these are applied.

In all water works and sewerage systems, problems arise where it is desired to have reasonably accurate information on volume of flow, carrying capacity of a pipe or probable pressure in parts of a distribution system. Most or all of these problems can be solved by simplified methods with often no more tools or equipment than those ordinarily on hand.

Usually such solutions will be within necessary limits of accuracy. After all, hydraulics is not an exact science. The actual flow of water in pipes, whether water or sewer, may vary quite considerably from the results computed by the most reliable formulas. Pipes are bought in certain manufactured sizes, and where computations indicate a 9-inch pipe as necessary, a 10-inch pipe must be installed. No one can foretell with accuracy what the demands for water, or the volume of flow of sewage will be 10 or 20 years in the future. There is no branch of engineering where basic good sense and judgment are more needed than in planning for water works and sewerage facilities. With such good sense and judgment as a basis, the methods given herein will yield results that are accurate enough for nearly all practical purposes. Simplified formulas, charts, and tables that permit direct reading of answers usually will give adequate solutions without the use of higher mathematics.

In addition to such simplified formulas, tables and charts which can be used to solve common everyday problems in hydraulics, this article will present basic information on terms used in hydraulics and what they mean; and will describe and explain the various hydraulic relationships.

Units of Length and Weight

In the United States, Canada and England, the foot and the inch are the standard primary units of length.

● ***STRAIGHT lines, or lines with long, smooth curves, are better hydraulically; short bends cause loss of head.***

In most other countries the meter, which equals 3.28 ft. or 39.37 inches, is the standard unit of length. The meter is divided into centimeters, 100 of which equal a meter; and millimeters, each of which is one-tenth of a centimeter or 1/1000 of a meter. Therefore a centimeter equals 1/100 of 39.37 ins. or about 0.4 inch; and a millimeter is about 0.04 inch.

Also in the United States, Canada and England, the pound and the ounce are standard units of weight. In those countries that use the metric system, the kilogram is the standard unit of weight. The kilogram (meaning 1000 grams) is equivalent to 2.20 pounds. A gram therefore is 1/1000 of a kilogram or about 1/30 of an ounce. In laboratory work, milligrams are used, which are 1/1000 of a gram or one-millionth of a kilogram. The gram should not be confused with the grain. There are 7,000 grains in a pound or 437.5 grains in an ounce.

In the United States, the inch and fractions of an inch are commonly used in indicating pipe and equipment dimensions, as 3-inch

SIMPLIFIED

pipe, 5/8-inch bolt, etc. However, in using hydraulic formulas, dimensions such as sizes of pipe, orifice openings and depth of flow over a weir must be expressed in feet or decimals of a foot. For instance, in such hydraulic formulas, 15-inch pipe is 1.25-ft. pipe, 6-inch pipe is 0.5-ft. pipe; and 8 inches of head over a weir is 0.67 ft. of head.

Units of Liquid Volume

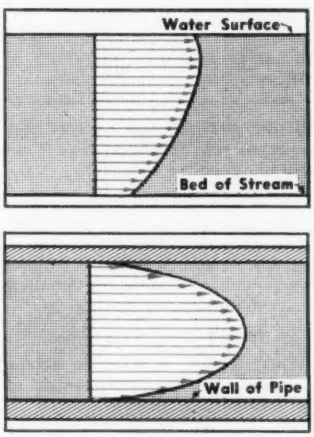
The gallon is one of the standard units of liquid volume in the United States. The same term "gallon" is also used in Canada and England, but it refers to the Imperial gallon which is 20% larger than the United States gallon. In this article, reference will be made invariably to the U. S. gallon, which contains 231 cubic inches and weighs (at standard temperature) 8.34 pounds. This weight is fairly constant under all usual conditions, but varies slightly with the temperature of the water. An Imperial gallon weighs 10.0 pounds. There are 1,728 cubic inches in a cubic foot and 231 cu. ins. in a U. S. gallon. Therefore there are 1,728 ÷ 231 = 7.48 U. S. gallons in a cubic foot.

The cubic foot contains 7.48 gallons and weighs (at standard temperature) 62.4 pounds. This weight is sufficiently accurate so that it can be used in all hydraulic computations, though there is some variation with the temperature of the water. The maximum density and therefore the greatest unit weight occurs at 39.3° F, at which temperature a cubic foot of water weighs 62.424 pounds; at 32° F, the weight is 62.416 pounds; at 100° F it is 62.0 pounds; and at 212° F it is 59.84 pounds. Sea water is heavier and ordinarily weighs about 64.1 pounds per cubic foot.

The liter is the standard unit of volume in those countries using the metric system. Roughly, the liter is slightly more than a quart (1 liter = 1.056 quart; 1 quart = 0.946 liter). The large volume metric measurement unit is the cubic meter (or stere) which equals 35.3145 cu. ft. or 264.15 gallons. In Latin countries, including South American nations, water plant and reservoir capacity are normally given in cubic meters. These are converted to cubic feet by multiplying by 35.3 and to gallons by multiplying by 264.2. In ship water supply, water is usually measured by the ton, which is 2,000 ÷ 8.34 = 240 gallons.

Though both gallons and cubic feet are used, the acre-foot is most commonly employed for storage measurement. The acre-foot represents an acre of area 1 foot in depth. Since an acre contains 43,560 square feet, an acre foot equals 43,560 cu. ft. or 325,829 gallons (43,560 x 7.48 = 325,829). Reservoir storage capacity is normally stated in acre-feet, especially in the case of large reservoirs.

Example.—A reservoir has an area of 250 acres and an average depth of 8 feet. Its capacity is 8 x 250 = 2000 acre feet, or about 651 mg.



● ***ABOVE, average stream velocity is about 0.8 surface velocity. Below, flow in a pipeline.***

Allowance must be made for the slope of the sides in computing reservoir capacity in this way. The surface area is generally much greater than the area 5 or 10 feet below the surface.

Volume-Time Measurements

When a continuing flow is to be measured, a time period also must be stated, as 1 cubic foot per second, 449 gallons per minute or 646,300 gallons per day. All of these are equal, since 1 cubic foot equals 7.48 gals; there are 60 seconds in a minute, and 7.48 x 60 = 448.81. There are 60 x 24 or 1440 minutes in a day, and 448.81 x 1440 = 646,300.

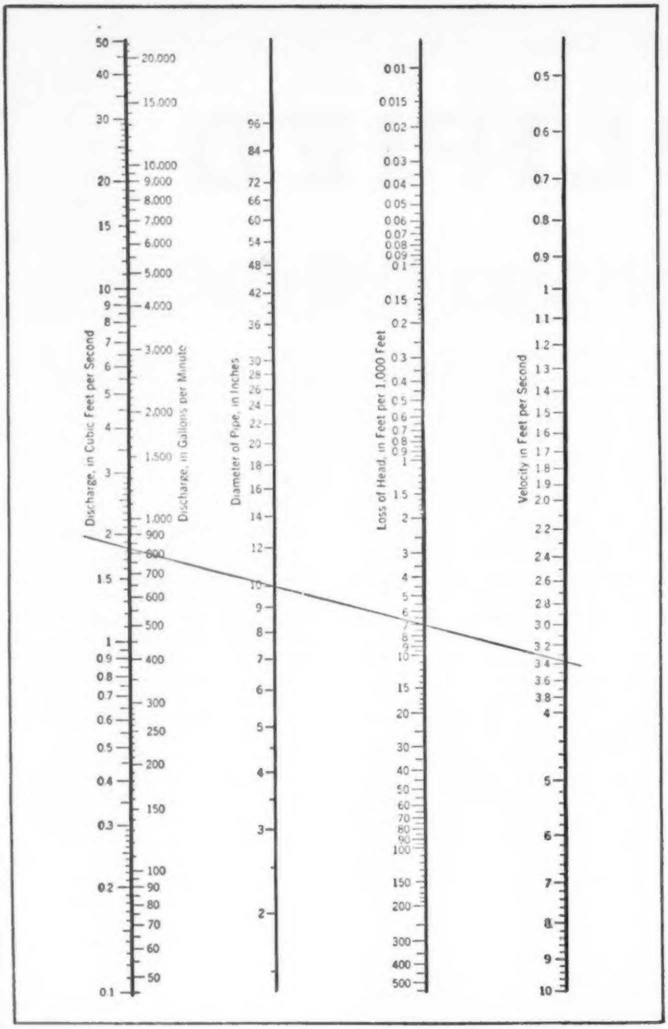
Cubic feet per second, abbreviated cfs, often also abbreviated second-feet (in England and some English Dominions *cusecs*) is used mainly to express the rate of flow in rivers, canals and storm sewers. The value in terms of gallons per second, minute and day is given in the preceding paragraph.

Gallons per minute, abbreviated gpm, is most commonly used to designate pump capacities. Gallons per minute x 1440 = gallons per day. For instance 700 gpm x 1440 = 1,008,000 gallons per day, or roughly 1 million gallons per day.

Gallons per day, abbreviated gpd, is used in rating waterworks capacities, water demand or water use. Often it is used as millions of gallons per day, abbreviated mgd.

The miner's inch is a term used mainly in the west. The amount has now been quite generally fixed by law and is 0.02 or 1/50 cfs in most midwestern states, and 0.025 or 1/40 cfs in the far western states, except Colorado which uses 0.026 or about 1/38 cfs.

Inches of runoff is frequently used to indicate the yield of drainage areas, and the time factor is usually the year in this case. In measuring the runoff from very in-



Nomograph for Hazen-Williams Formula with C=100 from Water Supply & Purification, by Hardenbergh, reproduced by courtesy of International Textbook Co., Scranton, Pa.

● ***TO USE this nomograph, C=100, put straightedge on any two known points on scales and read answer direct. For head loss 7' in 1,000, 10" pipe delivers 825gpm, shown by diagonal.***

tense storms, the term "inches of runoff per 24 hours" may be used. In storm drainage design, the runoff may be indicated in inches per hour, in the same way that rainfall is indicated; however, due to the relationship between inches of rain and cubic feet per acre of runoff, the runoff is often shown in cfs. The relationship mentioned is as follows: 1 inch of rain = 1/12 ft.: there are 43,560 sq. ft. in an acre; therefore 1 inch of rain per hour amounts to 43,560 ÷ 12 = 3630 cu. ft. per hour. Since there are 60 x 60 = 3600 seconds in one hour, 1 inch of rain per hour on one acre totals approximately 1 cfs if all runs off. If 50% runs off, the cu. ft. per sec. of runoff will be 0.5 times the rainfall rate in inches per hour times the drainage area in acres.

Heads and Pressures

The pressure of water in a pipe or tank is a factor of the weight of the water. As already stated, a cubic foot of water weighs 62.4 pounds. Assuming a cube of water, 1 foot on a side, the weight of the water pressing on the square foot of bottom area is 62.4 lbs. Since there are 144 sq. in. in a sq. ft., the pressure per sq. inch is 62.4 ÷ 144 = 0.433 lbs. The pressure of water against any surface is normal, that is, perpendicular, to the surface, and is of equal intensity in all directions. The intensity or amount of pressure is directly proportional to the depth of submergence or depth of water. The volume of water does not affect the pressure per sq. inch. The pressure is the same for a given height whether a reservoir contains a thousand or a million gallons.

The pressure per sq. in. due to each foot of head or depth of water is 0.433 pounds. For 60 ft. of head, the equivalent pressure is 60 x 0.433 = 26 pounds; for 100 feet it is 100 x 0.433 = 43.3 pounds. Conversely, a pressure of 50 lbs. indicates a head of 50 ÷ 0.433 = 115.4 ft.; a pressure of 70 lbs. indicates a head of approximately 161.5 ft.

Therefore to find pressure in pounds when the head is known, multiply the head by 0.433; to find the head in feet when the pressure is known, divide by 0.433 or multiply by 2.3.

The Suction Lift of Pumps

The suction lift of pumps is a function of atmospheric pressure. The atmosphere presses down on the earth surface with a weight, which at sea level amounts to 14.7 lbs. per sq. inch. This weight or pressure is called an atmosphere. A familiar demonstration of atmospheric pressure is a suction pump. At sea level, the 14.7 lbs. per sq. in. pressure equals 14.7 ÷ 0.433 = 33.9 feet of head of water. This is the theoretical limit of lift of suction pumps, but actually the practical lift is about 26 or 28 feet, due to friction losses, air bubbles in water, air leaks and similar factors. Also, as the elevation above sea level increases, there is a lesser weight of air and consequently a lesser suction lift.

A mercury column is often used to measure atmospheric pressure, and because mercury is much heavier than water, the height of mer-

Elevation Above Sea Level	*Atmospheric Pressure*	*Equivalent Height of Water*
0 (Sea level)	14.7	33.9 ft.
1000	14.16	32.65
2000	13.64	31.47
3000	13.15	30.34
4000	12.68	29.24
5000	12.22	28.18

cury column is less. A mercury tube is therefore often used to measure vacuum. Atmospheric pressure of 14.7 lbs. equals 33.9 feet of water, but only 29.92 ins. of mercury. The influence of elevation above sea level is shown in the accompanying table.

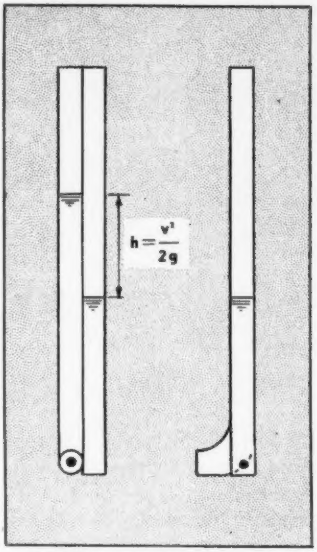
Thus, it will be seen that for each 1000 feet increase in elevation, the theoretical suction lift is decreased about 1.2 feet.

The vapor pressure is another factor influencing suction lift. Vapor pressure is the pressure existing at the surface of any liquid when the space above the liquid is confined or closed. This vapor pressure increases with the temperature; therefore the warmer the water is, the less the suction lift possible. Boiling water cannot be lifted by suction. The possible lift for water at 75° F is about 1 ft. less than for water at 32°; at 100° F it is 2.2 feet less; at 150° F it is 8.6 ft. less; at 200° F it is 26.6 ft. less. In other words, water having a temperature of 150° F can be lifted to a theoretical height of only 25.3 feet (less than this when above sea level); and water with a temperature of 200° F can be lifted only 7.3 feet under the most favorable conditions.

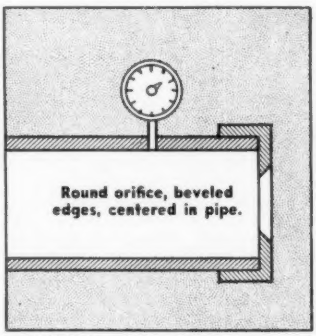
Hydraulic Definitions

The *velocity* in a pipe, channel, or stream, refers to the mean or average velocity. The various particles of water in a river have various rates of velocity—less near the banks and most in the middle at the surface. In pipes, the greatest rate of flow usually occurs in the middle of the pipe. In a stream, the average velocity at any point in the stream is about 0.8 of the surface velocity at that point. A more accurate method is to find the velocity at 0.2 and 0.8 of the depth, at points taken at a uniform distance apart across the stream, and average these. In pipes, the velocity, when the lower end of the pipe is discharging freely, depends upon the length of the pipe; the condition of its interior; the number of valves, bends or other obstructions; and the static head or pressure on the outlet end of the pipe.

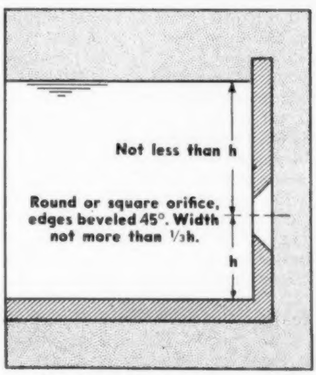
The *static head* is the vertical distance in feet (the difference in elevation) between the free water level of the source of supply and the free surface of the water into which it is discharged. The *effective head* at any point in a a conduit is equal to the static head less friction and other losses above that point. *Velocity head* is that part of the effective head that is represented by the velocity of flow at the point in question. This equals the vertical distance through which a body must fall in a vacuum to acquire this velocity and is represented by the formula $v^2 = 2gh$, where $g = 32.2$ and h is the head in feet. The total *dynamic head,* a term used in pumping, is the sum of all the pressures a pump must work against—the static head; all pipe friction; suction lift, if any; and the velocity head at the end of the discharge pipe.



● ***FRONT and side views of pitot tube show velocity calculation.***



● ***FLOW calculations by use of an orifice are described on p. 68.***



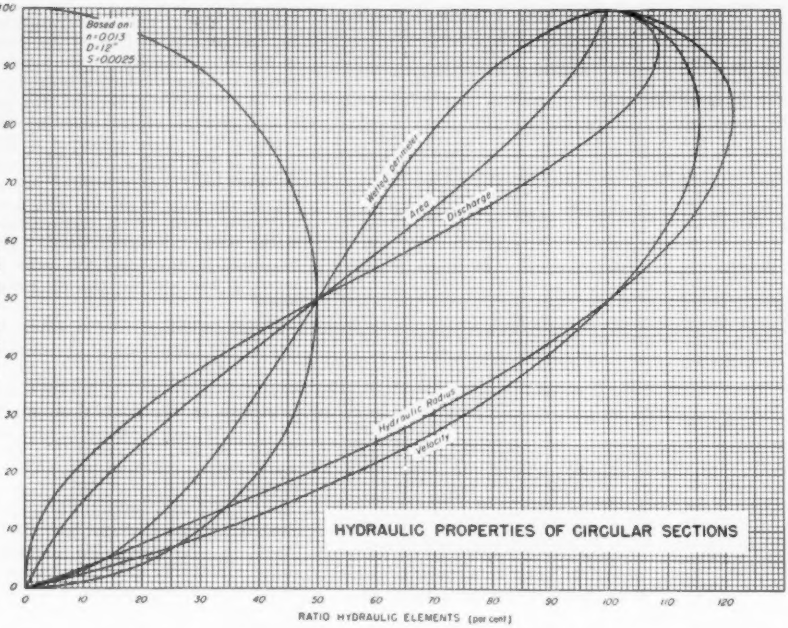
● ***DIAGRAM shows conditions for a standard orifice in a tank.***

Heads or differences in elevation should be determined accurately. Do not guess at heads. An engineering survey will cost very little compared to the cost of an error. Before pipe lines are laid, surveys should be run to determine that the elevation or head available is sufficient to deliver the desired amount of water through the size of pipe it is intended to use. High points in pipe lines are undesirable, as indcated later, and should be permitted only where it is certain that they will not interfere materially with the flow. Careful planning is an essential element in any job.

Terms and Usages

Slope is the rate of fall. In hydraulics this term is generally meant to indicate the fall per 1000 feet. In formulas, slope is commonly indicated by *s*. A slope of 5 feet in 1,000 is 5 ÷ 1000 or .005. The term $s = .005$ means the slope is 5 ft. in 1000 feet of *horizontal* distance. However, in most cases in hydraulics the difference between the horizontal length and the actual or sloping length of the pipe or canal is very small and can be neglected, and the actual length of the pipe or canal is used. Even on a 10% slope, where there is 100 feet of fall in 1000 feet ($s = .100$), the error due to using the actual length of the pipe instead of the horizontal or level length is only about ½ of 1%.

The *hydraulic gradient* is the line joining the elevations to which the water in a pipe line would rise in vertical tubes connected to it while water is flowing through the line. If the lower end of the line is plugged, the hydraulic gradient is a horizontal line; but if the line is allowed to flow freely, friction and other losses in the pipe reduce the pressure as the outlet is approached. If possible, there should be no point in a pipe line that intersects or rises above a straight line drawn from the outlet of the pipe line to the surface of the reservoir from



● THIS chart of the properties of hydraulic sections shows the variation of velocity and discharge in partially filled pipes. Note that the greatest discharge occurs when the pipe is .935 full.

Courtesy Clay Products Assn.

which the pipe draws. A high point cutting into this line reduces the volume of water that can be delivered.

The *wetted perimeter*, important in computing flows, indicates that portion of the perimeter of a cross-section (or inside area) of the conduit that is in contact with the flowing liquid, and therefore that part where friction between water and conduit surface is developed. In water pipes, which normally flow full of water, the wetted perimeter is the entire interior wall of the pipe; for round sewers flowing, let us say, half-full, it is one-half the interior wall. For canals having straight or sloping walls, the amount of wetted perimeter depends on the shape of the canal or conduit and the depth of flow in it. For example, remembering that, in hydraulic formulas, pipe sizes are always expressed in feet and that the circumference of the pipe is the diameter times 3.14:

(1) An 8-inch water pipe flowing full has a wetted perimeter of 0.667 x 3.14 = 2.09 ft.

(2) A 12-in. sewer flowing half full has a wetted perimeter of 1 x 3.14 ÷ 2 (since it is but ½ full) = 1.57.

(3) A rectangular conduit 4 ft. wide carries 1 foot of water. The wetted perimeter amounts to 1 + 4 + 1 = 6 ft. That is, the water touches the side walls to a depth of 1 ft. on each side and, of course, wets the entire 4-ft. width of the bottom.

The wetted perimeter is essential in hydraulic measurements because it affects the *hydraulic radius*, which will be discussed next. In hydraulic tables and formulas, the wetted perimeter is usually designated as *p*.

The *hydraulic radius* of a pipe or conduit is the cross-sectional area of the stream of water divided by the wetted perimeter. For instance, an 8-in. pipe flowing full has a cross-sectional area of .667 x .667 x 3.14 x ¼ = 0.35 sq. ft. The wetted perimeter, as indicated in the preceding paragraph, for an 8-inch pipe is 2.09 ft. The hydraulic radius, therefore, is 0.35 sq. ft. ÷ 2.09 ft. = 0.167 ft. The hydraulic radius of any circular pipe that is flowing either full or half full is ¼ the diameter. The cross-sectional area of the 12-inch sewer flowing ½ full is ½ (1 x 1 x 3.14 x ¼) = 0.39; and the wetted perimeter, as previously shown, is 1.57. Then the hydraulic radius is 0.39 ÷ 1.57 = 0.25 ft., or ¼ the diameter.

In the case of the rectangular conduit, the cross-sectional area of the stream is 1 x 4 = 4 sq. ft. The wetted perimeter was shown to be 6 ft. The hydraulic radius is therefore 4 ÷ 6 = 0.667 ft. If a conduit is 4 ft. wide and 3 ft. deep, the cross-sectional area of water is 12 sq. ft., and the wetted perimeter is 10 ft. The hydraulic radius is therefore 12 ÷ 10 = 1.2 ft. To illustrate the variation caused by a shallow stream, assume this conduit is 12 ft. wide and 1 ft. deep. The cross-sectional area is still 12 ft.; the wetted perimeter is 12 + 1 + 1 = 14 ft. and the hydraulic radius is 12 ÷ 14 = 0.86 ft.

The value of the hydraulic radius, commonly indicated by *r* in hydraulic formulas, indicates quite clearly the flow qualities of a conduit or channel; for while p is the main factor in determining the amount of friction developed (velocity and other conditions being equal), the energy for overcoming such friction is proportional to the volume of water flowing, which in turn is proportional to the area; and *r* indicates the relation between these. With all other conditions the same, the larger the hydraulic radius, the better the flow quality.

Long and Short Pipes

The length of a pipe, as compared to its diameter, is important in hydraulics because of the effect of friction. A *long* pipe is classed as one whose length is at least 1000 times its diameter—that is 500 ft. of 6-inch pipe, 1000 ft. of 12-inch, etc. A *short* pipe has a length less than 1000 times its diameter, but more than 60 times. A *very short* pipe has a length not greater than 60 times its diameter. A *standard tube* has a length 2½ times its diameter.

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The length of lines in pipe formulas is usually indicated by l.

Factors Affecting Flow

Among the factors that affect the flow of water in pipes and channels are the following:

(1) The friction of the water against the walls of the pipe or the bottom and side walls of a canal. The rougher the walls, the greater is the friction.

(2) The size of the opening in the pipe. The hydraulic radius for a small pipe is less than for a large one. Thus the wetted perimeter of a 12-inch pipe is 3.14 ft., while for a 24-inch pipe it is 6.28 feet. The cross-sectional area of the 12-inch pipe is 0.78 sq. ft. and of the 24-inch pipe 3.14 sq. ft. Then the hydraulic radius of the 12-inch pipe is 0.25 ft. and of the 24-inch pipe is 0.50 ft.

(3) The age of the pipe. As pipes remain in use, the inner surface may become rough and pitted, deposits may form reducing the area available for the flow of water, or moss or other growths may form on the interior, producing both a roughening effect and a decreased section.

(4) The longer the pipe the greater the resistance to flow, since each lineal foot exerts its own resistance.

(5) Increased pressure affects friction only as it causes greater velocity.

(6) Valves and other fixtures, bends, tees, etc., provide some increased resistance to the flow, due to interference with the stream of water, through eddies, etc.

(7) Obstructions in the pipe, as fins from improperly made joints, interfere with the flow. Air bubbles may collect at high points in the line and obstruct the flow of water.

Friction in Pipe Lines

The resistance to the flow of water through a pipe is called *friction*, or *friction loss*, or *friction head*. The amount of friction depends on a number of factors, including the following:

(1) The length of the pipe: A pipe that is 2000 feet long offers twice as much resistance to flow as one that is 1000 ft. long. This means that computations can be based directly on the length of the pipe.

(2) The velocity: Just as in the case of an automobile, the faster it goes, the greater the power required. In fact, the friction loss varies as the square of the velocity, being about 4 times as great for a velocity only twice as great, and nearly nine times more when the velocity is 3 times as great. For instance, a velocity of 1 ft. per second causes a loss of head of 0.85 ft. in 1000 feet of 6-inch pipe; with a velocity of 2 feet per second in the same pipe, the loss of head is 3.22 feet; with a velocity of 3 feet per second, other conditions being the same, the loss of head is approximately 7.0 ft.

(3) The diameter of the pipe: The friction is inversely proportional to the diameter of the pipe, that is, it is about ½ as much for an 8-inch pipe as for a 4-inch. For instance the friction loss in 1000 ft. of 4-inch pipe at 1 ft. per second velocity is 1.33 ft., while under the same conditions it is but 0.62 ft. for an 8-inch pipe. However, a short piece of smaller diameter pipe inserted in a larger line does not matrially reduce the capacity of the line. Some cities stock a limited number of sizes of valves, using a 6-inch valve, for instance in 6-in., 8-in., and even 10-in. lines; a 12-in. valve in 12-in. to 18-inch pipes, etc. The change in size should be made gradually, as by a reducer.

(4) The condition of the pipe interior, as smooth or rough, greatly influences the flow of water in the pipe and in all formulas for flow allowance is made for this factor. Experience has shown that, as pipes become older, the interior usually becomes rougher and the carrying capacity of the pipe decreases. Thus in the Williams and Hazen formula, which is used in computing flows in water pipes, different values for the modifying coefficient c are used, according to the estimated condition of the interior of the pipe. Common values of c for various kinds and ages of pipe are as follows:

Kind of Pipe	Corresponding Value of c
New straight cast iron pipe	140
Good new cast iron pipe	120
Cast iron pipe 10 to 12 years old	110
Cast iron pipe 15 to 20 years old	100
Cast iron pipe 25 to 30 years old	90

These values of c can be used in connection with loss-of-head tables presented later; full explanation of their use will be given then.

(5) Pressure in the pipe has no effect on the friction loss and therefore may be wholly neglected in computing flows.

A valve, even when open, interferes somewhat with the flow of water through a pipe; if the valve is partly closed, the interference will be greater. A globe valve offers more resistance than a gate valve; so will an angle valve. Elbows, sudden reductions or increases in size of pipe, tees and other fittings also interfere with the flow. Gradual reductions or increases in size cause little loss of effective head.

Valve and Fittings Resistance

This resistance to flow is usually measured in terms of equivalent length of straight pipe, and in computing the resistance of flow this equivalent in length is added to actual length of the pipe. For instance, it has been determined that the resistance (consumption of effective head) of a 6-in. standard elbow to the flow of water through it is the same as the resistance of approximately 16 feet of straight pipe. Therefore, if in a 6-in. line 1000 ft. long, there are two elbows, the equivalent length of line is 1000 + 16 + 16, or 1032 ft., and this length should be used in computing flow.

Table I (p.66) shows the approximate resistance to flow, of various valves and fittings, for several sizes of pipe. The following examples show how this information is used:

Example 1. What is the equivalent loss of head in terms of straight pipe of a 12-inch gate valve ¼ closed?

Solution.—From Table I, see line 4, and under 12" read the answer—it is the same head that would be lost in a straight run of 40 ft. of 12-in. pipe.

Example 2.—An 8-inch line takes off from another 8-inch line by a T. What is the equivalent loss of head due to the T?

Solution.—From the table, line 9, read under 8-inch the loss of head is equivalent to 47 ft. of 8-inch pipe.

Example 3.—If no water is being taken off through the line mentioned in Example 2, what is the equivalent loss of head in the main 8-inch line due to the presence of the T?

Solution.—Line 13 gives the equivalent loss for the run of a standard T. In the 8-inch column, this is shown to be the same as a straight line of 8-in. pipe 14 ft. long.

Example 4.—There are two 45° elbows in a 12-inch line. What is the equivalent loss of head?

Solution.—From line 12, of the table, the equivalent loss of head for a 12" 45° elbow is shown to be 15 ft. For 2 such elbows, the loss would be 2 x 15 = 30 ft. of pipe.

Example 5—A 12-inch line is suddenly reduced to 6-inch. What is


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TABLE I—RESISTANCE TO FLOW DUE TO VARIOUS VALVES AND FITTINGS

(Fractions of feet are omitted)

1.	Resistance to flow in equivalent feet of straight pipe				
2. Type of fitting. Size:	4"	6"	8"	10"	12"
3. Gate valve, open	2	3	5	6	7
4. Gate valve, ¼ closed	14	19	26	33	40
5. Gate valve, ½ closed	70	100	140	170	200
6. Gate valve, ¾ closed	280	400	550	700	845
7. Globe valve, open	120	160	210	—	—
8. Angle valve, open	57	83	110	140	165
9. Standard T takeoff	22	36	47	62	74
10. Standard elbow	11	16	21	27	32
11. Long sweep elbow	7	11	14	17	20
12. 45° elbow	5	8	10	13	15
13. Run of standard T	7	11	14	17	20
14. Run of T reduced ½	11	16	21	27	32
15. Sudden contraction					
d/D = ¼	5	8	—	—	—
d/D = ½	4	6	8	—	—
d/D = ¾	—	3	—	—	7
16. Sudden enlargement					
d/D = ¼	11	16	—	—	—
d/D = ½	7	11	14	—	—
d/D = ¾	—	10	—	—	19

the equivalent loss of head in feet of pipe due to the reduction?

Solution.—d = 6 inches; D = 12 inches, d/D = ½. From line 15 of the table, under 6" pipe, the loss is equivalent to 6 feet of 6-inch pipe.

Note: For contractions and enlargements, d is the size of pipe shown in the table and is always the smaller pipe. D is the larger pipe. Thus for d/D = ¼, if d = 4", D = 16"; for d/D = ½, for 4" pipe, D = 8"; for d = 6", D = 12". The only equivalent d/D = ¾ in the sizes of pipes shown in this table is d = 6", D = 8"; d = 12", D = 16".

When pipes carrying water under pressure pass over hills, air bubbles may collect at the high points in the lines and form partial blocks, obstructing the flow of water. These obstructions can be prevented by placing air relief valves at the high points in the lines. These valves automatically release air as it collects, but close before the water can escape. If a pipe line does not deliver the expected or computed amount of water, it should be inspected for leaks and for high points where air locks may form.

Computing Flows

The elementary formula for flow is based on the following:

Quantity of flow = area of pipe opening x velocity of flow.

The area of pipe opening is known or can be computed from the pipe size. The velocity of flow is dependent on the head or pressure of water as affected or modified by the friction factors enumerated in the preceding paragraphs.

Formulas have been developed which take all these factors into consideration. By substituting in these formulas the values of pipe size, length of pipe and the head, with allowance for the condition of the interior of the pipe, the discharge can be determined. The use of such formulas involve higher mathematics. It is easier and simpler to utilize tables or charts which have been prepared by working out such formulas. These tables and the methods of using them will be described in the following sections.

In order to use tables given herewith, for estimating flow, the following information is required.

(1) The size of the pipe.

(2) The length of the pipe in feet.

(3) The difference in elevation between the water surface at the intake end of the pipe and the end of the pipe or the water into which it discharges. If more convenient, the gauge pressures can be taken at these points and converted into feet of elevation by dividing the pressures in pounds by 0.433.

(4) Information on the condition of the interior of the pipe.

Table II herewith shows the loss of head in feet per 1000 feet of pipe. In using the table, remember that it refers to new pipe for which the value of c is normally 120 to 130, depending on the care with which it is laid and the straightness of the lines, but also on the size of the pipe to some extent. For new pipe, 16-inch and larger, use c = 130; for smaller sizes use c = 120.

The table can also be used for old pipe, but an adjusting factor must be used. With the same head lost per 1,000 feet of pipe as is indicated in the table, the discharge shown should be divided by 1.10 for pipe 10 to 12 years old; by 1.20 for pipe 15 to 20 years old; and by 1.33 for pipe 25 to 30 years old. For example, 10-inch pipe 20 years old will carry 1,225 ÷ 1.20 = 1,000 gallons per minute with a loss of head of 10.4 feet per 1,000 feet of length.

These figures are based on average experiences. If pipes do not tuberculate or deposits do not form in them, the flow will be greater than these figures indicate. If the pipes are known to tuberculate or coat badly, a greater allowance should be made.

Also because a roughened pipe interior reduces the flow to what it would be with a smaller loss of head with a clean pipe, the figures for head lost per 1,000 feet of pipe may be modified by suitable factors and the flow read directly. These factors are, for pipe 10 to 12 years old 1.18; 15 to 20 years old, 1.40; 25 to 30 years old, 1.70. For ex-

TABLE II—PIPE FRICTION AND FLOW

For new, clean, smooth cast iron or steel pipe.

Head lost per 1000 ft. pipe	*Velocity in pipe*	*Discharge G.P.M.*
4-Inch Pipe		
1.3	1.0	39
2.9	1.5	59
5.1	2.0	78
7.7	2.5	98
10.9	3.0	117
14.6	3.5	137
18.8	4.0	157
23.6	4.5	176
28.8	5.0	196
34.5	5.5	215
40.6	6.0	235
6-Inch Pipe		
0.9	1.0	88
1.9	1.5	132
3.2	2.0	176
4.9	2.5	220
7.0	3.0	264
9.4	3.5	308
12.1	4.0	352
15.2	4.5	397
18.5	5.0	441
22.1	5.5	485
26.1	6.0	529
8-Inch Pipe		
0.6	1.0	157
1.4	1.5	251
2.3	2.0	313
3.6	2.5	391
5.0	3.0	470
6.8	3.5	549
8.8	4.0	627
11.0	4.5	705
13.4	5.0	783
16.0	5.5	860
18.9	6.0	940
10-Inch Pipe		
0.5	1.0	245
1.1	1.5	392
1.8	2.0	490
2.8	2.5	612
3.9	3.0	734
5.3	3.5	857
6.8	4.0	979
8.5	4.5	1105
10.4	5.0	1225
12.5	5.5	1350
14.7	6.0	1470

ample, new 8-inch pipe will carry 940 gpm with a loss of head of 18.9 ft. per 1,000; 18.9 ÷ 1.70 = 11; the tables indicate a discharge of 705 gallons with a loss of head of 11 ft., and this is the probable capacity of an 8-inch line 25 to 30 years old.

To determine flows, obtain (1) the difference in feet of elevation between the inlet water surface of the pipe and the outlet water surface, or obtain the pressure in pounds at the outlet and convert this to feet; (2) the length of the pipe; and (3) the size of the pipe it is intended to use.

Divide the feet of elevation or head by the length of the pipe, including losses for valves, bends, etc., in thousands of feet. This gives the head available per 1000 ft.

Example.—It is intended to use new 6-inch pipe. The head available is 18 ft. per 1000 ft. Read under 6-inch pipe; with a loss of head of 18.5 ft. per 1000, the velocity is 5.0 ft. per second and the discharge is 441 gpm. Since the head available is a little less than 18.5 ft., the discharge will be slightly less.

When a value lies between the values given in the table, it will usually be sufficiently accurate to average the figures.

Measuring Flows

Flows may be measured as well as computed. Numerous devices for measuring flows are available. These include meters, weirs and similar devices. There are three common types of meters—disc, current and flow.

In the disc meter, the passage of water through the meter revolves a disc, driving a register placed on top of the meter. This type of meter is usually used on services or other small pipes, less than 1½ or 2 inches in diameter. In general, these meters are very accurate.

Meter testing sets are available from a number of manufacturers. These, for small meters, normally consist of a tank and scale, permitting the water passed by the meter to be weighed or otherwise measured, and thus checked against the meter reading.

The current meter consists of a wheel with curved blades. The velocity of the water passing through the pipe causes the wheel to revolve at a rate depending on the velocity. Current meters are simple and fairly accurate for velocities in the pipe greater than about 2 feet per second. At lower velocities, the wheel may not move, or may under-measure. Such current meters are made in sizes from about 4-inch up to 12-inch or larger. They may be fitted with gears so as to indicate the amount of flow directly on a dial. If in good condition, and operated within the velocity ranges of 2 to 5 feet per second, current meters inserted in a pipe will give fairly reliable results.

Compound meters consist of a combination of a small disc meter and a larger current meter. A built-in device allows small flows to pass through the disc meter, but when the capacity of this has been reached, the flow is diverted through the current meter. As a result, good accuracy is obtained.

Flow Meters.—When the area of a pipe is decreased, the velocity of the water flowing through it is increased and the pressure thereby decreased. Therefore, if the diameter of a short section of the pipe is reduced, and devices for indicating the pressure are inserted ahead of and also in the reduced-size section, means for measuring the flow are available, due to the fact that the relative pressure in these devices vary with the velocity of the flow. The devices for indicating the pressure usually consist of small tubes, containing mercury. For any given flow, the difference between the heights of the mercury in the two tubes permits almost exact calculation of the flow. By means of floats or by electrical action, the flow may be indicated on a dial. Each meter must be calibrated and adjusted to the flow for that particular size of pipe and range of pressures. The decrease in section of the pipe may be accomplished by means of a Venturi tube or a modified orifice plate set in the pipe. Meters of this type are adapted for all sizes of pipes.

The Pitot tube consists of a tube with a short section bent at a right angle at the bottom. This can be inserted into a water pipe through a tap, or into a flowing stream of water. The tube is held vertical and so turned that the opening of the bottom bend faces the current. This will cause the water to rise in this bent tube to a height equal to the sum of the pressure head and the velocity head of flow in the pipe. Usually there is a straight companion tube connected alongside the bent tube and with its lower end at the same elevation. The water will rise in the straight tube to a height equal to the pressure head in the pipe, and the difference between the heads in the two tubes is the velocity head, from which the velocity can be calculated. A mercury tube or similar device is generally used in measuring velocities in pipes under pressure.

Equpment of this type is available from several manufacturers, who furnish specific directions covering each instrument. Theoretically the difference in readings in the two tubes should equal the velocity head, but allowances must be made for departures from ideal conditions, and each instrument must be calibrated. Velocities are normally measured at several points within the pipe in order to obtain a mean velocity head. Under average conditions, the mean velocity is about 0.83 of that measured at the center of the pipe.

Pitot tube equipment is convenient to use and suitable for quick, approximate determinations. It is not an accurate instrument, but is suitable for measurements ordinarily needed in water works procedures. It is best to purchase an outfit from a manufacturer and have one or two operators trained in its use by the manufacturer. It can be used for a number of purposes, including finding large leaks in a supply line, determining approximate flows in pipes, etc.

Orifice Measurements

Orifices can be used to measure pipe discharge in either of two ways: (1) The orifice is placed at the end of the pipe; (2) a thin plate containing an orifice is placed in the pipe, usually bolted between two flanges.

In the first case, a cap, in which a hole has been drilled, is screwed on the end of the pipe, or a plate with a hole in it is bolted onto the pipe end. In either case, the hole should be round, centered in the pipe and smoothly cut and beveled. A pressure gauge is necessary. This should be inserted in the pipe about 1 pipe diameter back from the orifice—that is, 6 ins. back for a 6-in. pipe, 10 inches back for a 10-inch pipe, etc.

The computation of the discharge is not difficult. Assume that the diameter of the orifice is ½ the diameter of the pipe—that is 3 ins.

TABLE III
Table of Values of A

Size of Orifice	*Value of A*
1"	0.0055
1½"	0.012
2"	0.022
2½"	0.034
3"	0.049
3½"	0.067
4"	0.087
5"	0.136
6"	0.196

TABLE IV
Table of Values of B

Pressure in Pounds	*Head in Feet*	*Value of B*
10	23	4.8
15	35	5.9
20	46	6.8
25	58	7.6
30	69	8.3
35	81	9.0
40	92	9.6
45	104	10.2
50	115	10.7

for a 6-inch pipe, 4 ins. for an 8-inch, etc. The discharge formula is

$$Q = c\ a\sqrt{h}$$

Where Q = discharge in cubic feet per second, c is a coefficient which for an orifice opening ½ the size of the pipe is 5.2; *a* is the area of the orifice in sq. ft.; and *h* is the head on the center of the orifice, in feet. It is easier to use this formula with gallons per minute discharge and pounds of pressure. Then:

Gallons per minute = 449 x 5.2 x A x B

Where A = the area in sq. ft. of the orifice. (See Table III).

B = the square root of head on the center of the orifice (See Table IV).

Example 1: A 6-inch pipe discharges through a 3-inch orifice. The pressure on the gage is 30 pounds. What is the discharge in gallons per minute?

The formula for discharge is 449 x 5.2 x A x B.

From the tables, A for a 3-inch orifice is 0.049 and B for 30 pounds pressure (equivalent to 69 ft. of head) is 8.3. Then 449 x 5.2 x 0.049 x 8.3 = 943 gpm.

Example 2: A 4-inch pipe discharges through a 2-inch orifice of the type shown in the illustration. The pressure on the gage is 20 pounds. What is the discharge in gallons per minute?

From the tables, A = 0.022 and B = 6.8.

Then 449 x 5.2 x 0.022 x 6.8 = 350 gpm.

If the opening in the orifice is greater or less than ½ the diameter of the pipe the factor of 5.2 in the formula will be greater or less. It is convenient with smaller pipes to make the orifice exactly ½ the pipe diameter.

The pressure should be read after the nozzle has been discharging a few minutes—long enough to get an average reading.

With relatively small flows and small heads it may be desirable to measure the discharge of a pipe by allowing it to flow into a wooden or concrete box and to measure the discharge by means of an orifice in the side or end of the box, or by means of a weir. The latter is usually better because the shape of the orifice influences considerably the amount of water that will pass through it.

A so-called *standard* orifice should be used. For accurate measurement, the head *h* on the orifice should be at least 3 times the vertical height of the opening o of the orifice and the orifice should be located at least 3 times the least dimension of the orifice from the bottom or any side wall.

For instance, an orifice 3 inches square should be at least 9 inches from the bottom or from either end, and for accurate measurement there should be at least 9 inches of water above the center of the orifice.

The formula for discharge in gallons per minute for orifices under the above description is

$$gpm = 2195 \times X \times Y$$

where X is the area of the opening in square feet (see Table V), and Y is the square root of the head on the center of the orifice in feet. This formula does not assume any velocity of approach: therefore the tank should be large enough so that the water is held relatively still.

TABLE V

Size of opening	Value of X
1" square	.007
1½" square	.016
2" square	.028
3" square	.063
4" square	.111

Procedure.—Construct the orifice carefully. Fasten an accurate rule to the inside of the tank, with its bottom at the elevation of the center of the orifice. Make the tank deep enough so that a head of at least 24 inches is available above the center of the orifice. Construct the orifice 1 inch square for flows of 12 to 25 gpm. Use a 2-inch square orifice for flows of 50 to 100 gpm; and a 3-inch square orifice for flows of 100 to 200 gpm. Flows that are larger than 150 or 250 gpm. are best measured by the pipe orifice method described previously. For flows between 25 and 50 gallons, either a 1½-inch square orifice can be used, or the head increased above 2 ft.

The tank should be allowed to fill until the discharge through the orifice equals the inflow. The level in the tank will then remain constant. Measure the head, as shown by the water surface on the rule.

Example 1. Using an orifice 2 inches square, the level of the tank into which the water is discharging remains uniform at 23 inches above the center of the orifice, what is the discharge into the tank?

Solution: From the formula,

$$gpm = 2195 \times X \times Y$$

From Table V, for an orifice 2 ins. square, X = 0.028 and from Table VI for a head of 23 ins., Y = 1.38. Then

$$gpm = 2195 \times 0.028 \times 1.38 = 85$$

The flow is 85 gallons per minute.

TABLE VI
Values of B

Inches Head on Orifice	Value of Y	Inches Head on Orifice	Value of Y
9	.87	17	1.19
10	.91	18	1.22
11	.96	19	1.26
12	1.00	20	1.29
13	1.04	21	1.32
14	1.08	22	1.35
15	1.12	23	1.38
16	1.15	24	1.42

Example 2. Using an orifice 3 ins. square, the level of the tank remains constant at 18½ ins. above the center of the orifice.

Solution: Using the formula above, X = 0.63, from Table V and from Table VI, the value for Y of 18½ ins. may be taken midway between 18 ins. and 19 ins., or 1.24.

$$gpm = 2195 \times 0.063 \times 1.24 = 172$$

and the flow is therefore 172 gpm.

Discharge from Fire Hydrants

It is often convenient to know the amount of water that is discharged from a fire hydrant. There is more than one way to do this, but the simplest way is to measure carefully the diameter of the inside of the hydrant nozzle or connection. Then tap a pressure gauge into a cap that is threaded to fit on one of the nozzles or connections. Where a hydrant has 3 connections, the flow can be measured from either one or two of them, the pressure gauge being placed on one. (It may be placed on the steamer connection if there is one). The discharge from one or both nozzles can be computed easily from the diameter and the reading of the pressure gauge while the hydrant is flowing. An approximate formula, accurate enough for ordinary purposes, is $27\, d^2 \sqrt{p}$, where d is the diameter of the opening in inches. Table VII gives readings accurate enough for most purposes. Where the exact pressure is not shown, average the figures for the two nearest readings.

TABLE VII
Discharge in Gallons per Minute for Various Pressures and Nozzle Sizes. Inside Nozzle or Connection Sizes in Inches

Pressure, Pounds Per Sq. Inch	2⅜	2½	2⅝	3½	4
½	110	120	130	240	300
1	150	170	190	320	440
2	210	240	260	460	610
3	260	290	320	560	750
4	300	340	370	660	860
5	340	380	420	750	960
7	400	450	490	880	1150
9	460	510	560	1000	1300
11	510	560	620	1100	1440
13	550	610	670	1200	1550
15	590	650	720	1280	1670
17	630	700	770	1360	1790
20	680	750	830	1470	1940

Example 1. A hydrant has 3 nozzles, each 2½ inches internal diameter. A pressure gauge placed on a cap fitting over one of these nozzles registers a pressure of 16 pounds when the other two are discharging fully.

How much water does the hydrant deliver?

Solution. From Table VII it will be found that a hydrant will discharge 650 gpm through a 2½-inch nozzle with a pressure of 15 pounds and 700 gpm at 17 pounds. The average of the two figures may be taken as the discharge at 16 pounds. Then each nozzle will discharge 675 gpm and the two nozzles will discharge 2 x 675 = 1350 gpm.

The figures in the table are to the nearest 10 gallons. It is useless to attempt greater accuracy.

Example 2. A hydrant having a nozzle opening of 2 9/16 in. in diameter discharges under a pressure of 17 pounds. What is the discharge in gallons per minute?

Solution. While there is no discharge shown for a 2 9/16-inch opening, figures are given for 2½ and 2⅝-inch openings. The 2 9/16-inch nozzle discharge will be about midway between the discharge for the next smaller and next larger openings. For 17 pounds pressure, the 2½-inch nozzles, according to Table VII, discharges 700 gpm, and the 2⅝-inch nozzle 770 gpm. Therefore the 2 9/16-inch nozzle will discharge about 735 gpm.

The measurement of discharge from a hydrant is not generally used merely to determine flow, but usually to determine how much water is available for fire protection at any hydrant or in any section of the city. The average fire hose under a pressure of about 50 pounds discharges 200 gallons per minute. It is easy to determine how many hose lines can be used effectively on a hydrant or group of hydrants.

If the pressures given in the table are lower than those actually found, more hydrants can be opened, thus reducing the pressure so that the table can be used. The total discharge will be the sum of the discharges from all the hydrants.

From the discharge results obtained, and from the pressure drop, additional information of value may

TABLE VIII

Pressure	Sq. Root	Pressure	Sq. Root	Pressure	Sq. Root
10	3.2	28	5.3	46	6.8
12	3.5	30	5.5	48	6.9
14	3.7	32	5.7	50	7.1
16	4.0	34	5.8	52	7.2
18	4.2	36	6.0	54	7.3
20	4.5	38	6.2	56	7.5
22	4.7	40	6.3	58	7.6
24	4.9	42	6.5	60	7.7
26	5.1	44	6.6	62	7.9

be obtained, including the estimated discharge at lower or higher pressures, based on the pressure in the mains before opening the hydrants and the pressure when the hydrants were fully open. The data obtained is this way are not very exact, but may be of value. It is based on the square roots of the pressure drops, that is, $\sqrt{d}$, where d is the drop in pressure. For instance, if the static pressure before opening the hydrant were 61 pounds per sq. inch; and at a drop to 36 pounds the discharge amounted to 1600 gpm, how much would the discharge probably be at a discharge pressure of 25 pounds? The drop in pressure from 61 to 36 pounds was 25 pounds. The square root of 25 is 5. At a pressure of 25 pounds, the pressure drop is 61—25 = 36 pounds and the square root of 36 is 6. The probable flow, if the hydrants were open sufficiently to drop the pressure to 25 pounds, would be

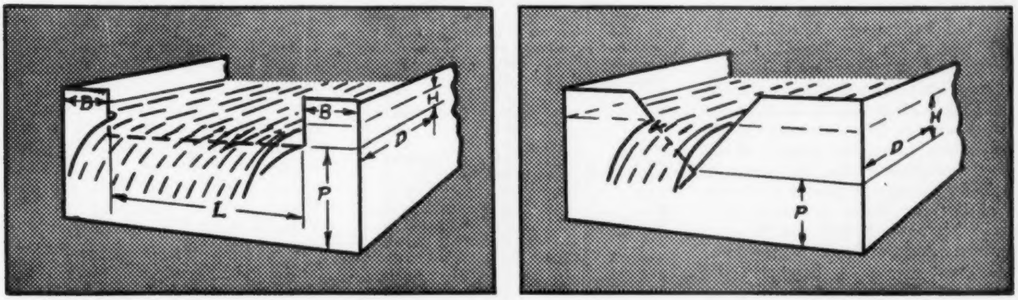
$$\frac{1600 \times \sqrt{36}}{\sqrt{25}} = \frac{1600 \times 6}{5} = 1920 \text{ gpm.}$$

Tables showing square roots and also squares, areas of circles, and much other handy information are available in hydraulic or mathematical handbooks, and also in several of the handbooks issued by manufacturers of water works equipment. Such books usually contain more detailed and useful figures on flow than it is possible to give in this article.

Measuring Flows With Weirs

The term "weir" is often used to designate a dam, usually a particular type of low dam, and from this loose use of the term has been derived an exact meaning of the word "weir". When considered as a measuring device, a weir is a notch or opening in the top of a vertical dam through which the water flows. Many experiments have been made to determine how much water will flow over a weir with a given head or depth of flow, since weirs are often the cheapest and also may be the only method available for the accurate measurement of flow of a stream.

Slight changes in the construction of a weir will result in considerable variations in the amount of water passing over it. Therefore care must be used to construct weirs properly.



● *FORMULA for flow over weir with end contractions is based on L = 3H or more; and B, P and D = 2.5H or more. In V-notch weir P = H or more and D = 5H or more. Weir edges should be sharp.*

The waterway of weirs may be rectangular, triangular, or trapezoidal. Weirs are of two general types—with and without end contractions. In a weir with end contractions, the notch over which the water passes is narrower and shallower than the channel of the stream or the flume carrying the water. In a weir that does not have end contractions, the overflow notch is as wide as the channel leading to it. Such a weir is sometimes called a suppressed weir.

In the weir with end contractions, the formulas for flow are based on having the distances from the ends of the notch to the corresponding side walls of the flume or channel at least three times as great as the depth H of the water passing over the weir. Also the length of the weir crest L should be about 3 times H; the depth of the box or channel bottom below the crest of the weir P should be at least 2½ H and the distance back from the weir D at which the head H is measured should be 3H or not less than 3 ft.

In the suppressed weir (that is, one without end contractions) the sides should be smooth and straight and should project slightly beyond the bottom of the notch. Some arrangement must be provided for admitting air under the water passing over the weir, or the discharge rate will be increased and the formula for this type of weir will not be accurate.

The edge of the weir over which the water flows is called the crest. The inner or upstream edge of the crest is always made sharp, as with a chisel edge, so that the water in passing over touches only a thin edge or line. For usual work, it is sufficient to cut off a board so as to make an angle with the vertical (when the weir is in place) of about 30°. This is accomplished by measuring back from the edge to be beveled twice the thickness of the board. The beveling should be straight and the resulting edge thin, true, straight and level. The sides of the weir must be set square with the crest. To obtain accurate measurements, accurate and careful work is necessary.

For accurate measurements weirs should meet the following requirements: (1) The weir must be placed perpendicular to the direction of flow and it must be vertical; (2) The crest should be sharp—not over 1/16 inch wide—smooth and level; (3) The surface of the water downstream must be lower than the crest of the weir; (4) It must be possible for air to enter beneath the sheet of water falling over the weir; (5) The channel of approach to the weir must be straight and unobstructed; (6) A depth of flow over the weir of 0.2 ft. to 2.0 is desirable for accurate measurements. Therefore the weir should be sufficiently long or wide to maintain the depth of flow between these ranges.

In regard to (3) above, the bottom of the channel, when weirs with end contractions are used, should be about 2½ H (2½ times the depth of flow over the crest) below the crest.

The head or depth of flow over a weir is measured upstream from the crest of the weir. This is necessary because the water, as it approaches

the edge of the weir, curves downward and the depth measured at the crest would be less than the actual head. With a level, set a rule or gauge with its bottom or zero at the elevation of the crest, placing the rule 3 or 4 feet or more back from the weir. Then the head or depth of flow can be read directly from the gauge or ruler.

The factors influencing the amount of flow over a suppressed weir that has been properly constructed as already described are (1) the width or length of the notch and (2) the depth or head of flow over the crest. In regard to the length of the notch or opening, the amount of flow is almost exactly dependent upon the length. If all other conditions are the same, a weir 4 ft. long will discharge almost exactly four times as much as a weir that has a length of 1 ft.

As the head or depth of flow over the crest increases, however, the volume of flow increases still more rapidly. Thus, a weir 1 foot wide may discharge approximately 1.2 cubic ft. per second (or 540 gpm) when the depth of flow over it is 6 inches; but, with a depth of flow of 12 inches, the discharge will be approximately 3.34 cfs.; and with a depth of flow over the crest of 18 inches it will discharge about 6.1 cfs. Therefore, careful measurement of the actual depth of flow over a weir is necessary.

Under usual conditions, measurements of flow over a weir may be expected to be in error by as much as 5%, even when the weir is constructed carefully. As already pointed out, this degree of accuracy is generally sufficient for most hydraulic computations.

Though the tables herewith shown dimensions in inches and discharges in gallons per minute, all weir discharge formulas use dimensions in feet and show discharges in cubic feet per second.

Table IX herewith gives the volume of flow over a weir 1 ft. long, without end contractions as computed by the Francis formula, for varying heads or depths of flow over the crest. Although it is desirable to have a minimum head or depth of flow over the crest of about 2½ inches, approximate flows for lesser heads are given. To obtain flows over longer weirs, multiply by the length of the weir in feet.

Example 1. A weir without end contractions is 24 inches long and the head H, or depth of flow over the crest is 5¼ inches. How much water is passing over the weir in gallons per minute?

Solution. The flow per foot of length of weir for a head H of 5 ins. from Table IX 402 gpm; for 5½ ins. it is 466 gpm. Therefore, for 5¼ ins., it will be approximately 402 + 466 ÷ 2 = 434 gallons per minute; and for a weir 2 feet long it will be 2 x 434 = 868 gpm.

TABLE IX

Discharge Over Suppressed Weir 12" Long for Varying Heads

Depth of flow over weir	*Discharge gallons per minute*	*Depth of flow over weir*	*Discharge gallons per minute*
½ inch	12	4¼ inch	316
¾ "	22	4½ "	344
1 "	34	4¾ "	373
1¼ "	47	5 "	402
1½ "	62	5½ "	466
1¾ "	74	6 "	530
2 "	101	6½ "	595
2¼ "	124	7 "	665
2½ "	142	7½ "	739
2¾ "	164	8 "	815
3 "	187	8½ "	893
3¼ "	211	9 "	980
3½ "	236	10 "	1145
3¾ "	261	11 "	1318
4 "	287	12 "	1500

Example 2. A weir without end contractions is 30 ins. long. The head H or depth of flow over the crest is 7⅛ inches. What is the discharge in gallons per day?

Solution: From Table IX, the discharge over a weir 1 ft. long for a head of 7 ins. is 665 gpm. For 7½ ins. it is 739 gpm. The difference due to ½ in. or 4/8 is 739 — 665 = 74 gallons. The approximate difference for each ⅛ inch is 74 ÷ 4 = 18½. Therefore the discharge for a H of 7⅛ ins. will be about 739 + 18 = 757 gpm per foot of length. For a weir 30 ins. or 2½ feet long, the discharge will be 757 x 2½ = 1892 gpm. Since 700 gpm equals approximately 1 mgd, 1892 ÷ 700 = 2.7 mgd.

The flow over a weir with end contractions is affected to some extent by the contractions at the ends. On a long weir, and especially when the head over the weir crest is not great, the effect is of little importance. It has been found that the contraction of the flow affects the discharge to the same extent as if the length of the weir were reduced by 0.2 of the head over the weir. In practice this means that where the head over the weir is more than about one-twentieth of the length of the crest, an allowance should be made for the contractions.

For a weir with end contractions, therefore, assume the length of the weir is reduced by 0.2 of the H and use the table already given for weirs without end contractions.

In the "Cippoletti" weir the effect of the end contractions is compensated for by giving the ends of the weir a slope of about 4:1, in which case the discharge is approximately the same as for a suppressed weir with an equal length of crest. In a "Sutro" weir the ends have the form of arcs that so contract the width of the sheet of water flowing over it as the head increases, that the volume of flow is directly proportional to the head.

V-Notch Weirs

The rectangular weir is not well suited for measuring small flows, as will be noted by reference to the discharges shown in Table IX. With such weirs a depth of 2 ins. over the weir crest gives a flow for a weir 1 ft. long, of only 101 gpm. A greater range of capacities, and greater accuracy with small flows are obtained with a triangular or 90° V-notch weir. To obtain accurate results, the sides of the channel or the contractions should be set well back; the weir should be exactly perpendicular or at right angle to the flow; it should be set in a straight channel; the bottom of the notch should be exactly 90°; the edges should be straight and beveled, as previously described for rectangular weirs; the depth of the channel below the notch of the weir should be at least as great as the maximum head over the notch of the weir. As with the rectangular weir, the head should be measured 3 or 4 or more feet upstream in order to avoid a false reading due to the slope of the water near the weir.

There are several formulas for flow over a V-notch weir; most of these give approximately the same results. The King formula is: Discharge in gallons per minute = $1131.5 \times H^{2.47}$, where H is the head in feet of flow over the notch of the weir. Table X gives the discharge for usual ranges of flow, based on inches of depth of liquid flowing through the notch.

TABLE X

Discharge of Triangular Notch Weirs

Head in Inches	*Flow in GPM*	*Head in Inches*	*Flow in GPM*
1¼ inch	4.2	5½ inch	165
1½ "	6.6	6 "	204
1¾ "	9.8	6½ "	249
2 "	13.6	7 "	299
2¼ "	18	7½ "	355
2½ "	23.5	8 "	416
2¾ "	30	8½ "	485
3 "	37	9 "	556
3¼ "	45	9½ "	635
3½ "	54	10 "	721
3¾ "	64	10½ "	813
4 "	75	11 "	913
4½ "	100	11½ "	1020
5 "	130	12 "	1131

Example. A standard triangular or V-notch weir flows with a head, indicated by a gauge 4 feet back from the crest, of 4½ inches. What is the rate of overflow in gallons per minute?

Solution. From the Table, a head of 4½ inches shows that the flow is 100 gallons per minute.

Example. The head over a standard V-notch weir, measured by a gauge well back from the weir crest, is 8⅜ inches. What is the flow in gallons per minute?

Solution. From the table, the flow for 8 inches of head is shown to be 416 gpm., and for 8½ inches 485 gpm. The ½ inch difference indicates an increased flow of 485 — 416 = 69 gpm; the flow when the head is 8⅜ inches will be 416 gpm plus about 52 gpm. Therefore the flow with 8⅜ ins. is 416 + 52 = 468 gpm.

How to Compute Flows in a Distribution System

It is possible to compute quite closely the flow of water through the network of a distribution system, though in a complicated network the procedure is lengthy. Procedures for the solution of some simpler problems will be presented here. For a more complete treatment of the problem, the reader is referred to Babbitt & Doland's Water Supply and Hardenbergh's Water Supply and Purification. A rapid method, developed by T. F. O'Connor, engineer of the Department of the Army was published in the 1943 Proceedings of the Maryland-Delaware Water and Sewerage Association. A good set of tables showing flow of water in pipes, with loss of head for the various flows and pipe sizes is essential. These are available in many text books and in the publications of many pump manufacturing companies.

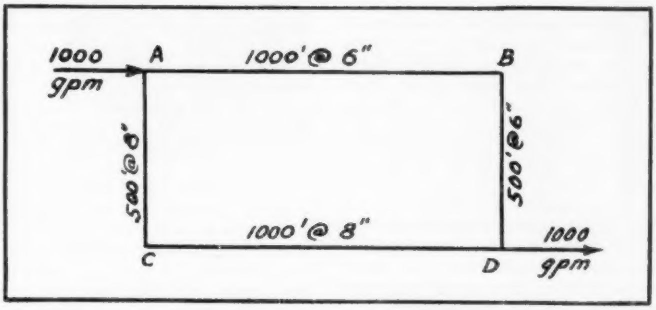
It may be simpler, as suggested by O'Connor, to convert all pipe lengths into equivalent sizes. In a system in which there are 4, 6, 8, 10 and 12-inch pipes, 8-inch may be adopted as the standard. In a small system where there may be 4, 6 and 8-inch, it may be easier to convert to equivalent lengths of 6-inch. In this article, all pipe lengths will be converted to equivalent lengths of 8-inch. Based on C = 100 for pipe 15 to 20 years old, the resistance to flow through 100 ft. of 8-inch pipe is the same, for the purpose of this article, as: 2,940 ft. of 4-inch; 406 ft. of 6-inch; 100 ft. of 8-inch; 34 ft. of 10-inch; and 14 ft. of 12-inch.

The solution of a problem of this nature involves certain trial and error procedures, which are not difficult and do not necessarily involve mathematics other than arithmetic. The solution of a simple problem is illustrated herewith:

Example: Determine the flow through each branch of pipe shown.

As a first step, simple inspection indicates that more water will flow through the loop of 8-in. pipe ACD than through the 6-in. loop ABD. It will, therefore, be assumed that 600 gpm will pass through the 8-in. section and 400 gpm through the 6-in. section.

The next step will be to convert the 6-in. line to equivalent 8-in.



Precise figures are not necessary and it will be assumed that the 6-in. line equals 4,100 + 2,000 = 6,100 ft. of 8-in. Reference to flow tables shows that loss of head for 600 gpm through ACD is 11.4 ft. per 1,000, or a total of 17.1 ft.; and the loss of head through ABD for 400 gpm is 5.4 ft. per 1,000 or 6.1 x 5.4 = 32.9 ft. It is clear that the flow through ABD will be less than 400 gpm, while through ACD it will be more than 600 gpm. A basis for estimating the correction for the next trial is needed and is available.

The difference in head in the two circuits is 32.9 — 17.1 = 15.8 ft. In each circuit the head is divided by the flow, thus

ACD : 17.1 ÷ 600 = .0285
ABD : 32.9 ÷ 400 = .0822

Correction factor .1107

This correction factor is multiplied by 1.85, a factor based on the Hazen-Williams formula, as follows: 1.85 x .1107 = 0.205. This is divided into the difference in head in the two circuits, 15.8 ÷ 0.205 = 77. This is the probable correction, in gallons per minute, for the flows in the two circuits. The circuit showing the greater loss of head will have its flow diminished 75 gpm. (this is close enough for the second trial) and the ABD circuit will be increased accordingly. The adjusted flows will then be: ABD, 325 gpm; and ACD, 675 gpm.

A flow of 675 gpm through 1,500 ft. of 8-inch pipe will result in a loss of head of 14.4 ft. per 1,000 ft. of length, or 21.6 ft. for the 1,500 ft. in the circuit. A flow of 325 gpm through 6,100 ft. of 8-inch pipe will result in a loss of head of 22.9 ft. The difference in head loss is only 1.3 ft., so the flow will be very close to that assumed for the second trial. It can be verified as described above, and it will be found that the correction is about 6 gpm. The final flow in ABD will be 319 gpm and in ACD 681 gpm.

The same procedure can be used for almost any problem. Assume that 200 gpm is drawn off at B. The flow through the two loops, ABD and ACD will change, and will be based on the resistance of 1,000 — x gpm through AB, plus 1000 — x — 200 gpm through BD, with the remainder through ACD.

As a start, assume a flow of 400 gpm through AB, 200 gpm through BD and 600 gpm through ACD. The resistance of the flow AB + BD will be: (4.1 x 5.4) + (2.0 x 1.5) = 22.1 + 3 = 25.1. Through ACD, for 600 gpm, the resistance will be 1.5 x 11.4 = 17.1. Evidently our assumption of 400 gpm flowing through AB was too high. The correction will be based on the following: Difference in head lost is 8.0 ft.; 22.1 ÷ 400 = .055; 3.00 ÷ 200 = 0.015; 17.1 ÷ 600 = .0285. The total h/q = .0985. This multiplied by 1.85 and divided into 8.0 (the difference in the head lost in the two circuits) indicates a correction of about 40 gallons is desirable.

On this basis the flow through AB will be about 360 gallons; through BD, 160 gallons; and through ACD about 640 gallons. Computations on this basis indicate that these flows are within 5 gpm of being correct. The head loss through ABD is 20.5 ft., and through ACD 19.5 ft. Therefore the final flows will be about as follows: AB, 355 gpm; BD, 155 gpm; and ACD, 645 gpm.

How to Build EMULSIFIED ASPHALT SAND-MIX Pavements

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This is an abstract of a paper presented by Mr. Collier at the recent meeting of the American Road Builders' Assn.

THE topography of the State of Mississippi is essentially of three types: a low-lying coastal plain; flat delta lands which were once the bed of the Gulf of Mexico; and a rolling, hilly section. The use of emulsified asphalt sand mixes has been equally successful in each of these areas.

When construction of a section of emulsified asphalt sand pavement is contemplated, soil samples are taken at intervals from the existing roadway and gradation and stability of the material determined. It is sometimes necessary to haul in coarse sand for blending with the roadway material to reduce the minus #200 mesh content to a maximum of 15%. This sand is taken from beaches or river sand bars, and is usually graded as follows: 100% passing #10 mesh screen, 80 to 95% passing #40, 10 to 20% passing #80, 0 — 2% passing #200.

Construction Methods

Roadbed material is windrowed along the edge of the road with patrol graders in sufficient quantity to provide approximately one cubic foot per square yard per inch of compacted thickness. About one-third of this windrow is spread by a patrol grader over a 15-foot width of road, with a small berm left at the side opposite the windrow to prevent run-off of the emulsified asphalt. Sufficient water is applied by water truck to insure rapid and thorough mixing. One-third of the total requirement of emulsified asphalt is applied by pressure distributor in two or more applications, with the blade mixing operation proceeding between applications and continuing until the material is thoroughly mixed. This mixed material is windrowed on the opposite side of the road from the unmixed windrow, and the operation repeated until the entire windrow has been mixed. After two or three days, depending on drying conditions, and after the mix has taken its initial set, it is bladed back and forth across the road until sufficiently cured. This cured material is then laid out on the road with patrol graders and rolled with pneumatic rollers. The final finish is obtained by machining lightly with patrol graders, and rolling with a steel wheel roller.

About four days construction time per mile is required for a typical 18-foot emulsified asphalt sand-mix pavement 3 inches thick. The average crew consists of 6 men, with 2 patrol graders, one water truck, one pressure distributor, and rubber-tired and steel wheel rollers. The average cost of 3" pavement in the coastal area has been 33¢ per square yard for the emulsified asphalt and from 12¢ to 15¢ per square yard for equipment rental, labor and sand haul. Exclusive of sand haul, contract prices have been running from 50¢ to 60¢ per square yard. The cost of sand haul will vary from 3¢ to 5¢ per square yard depending on length of haul and quantity involved.

A typical example of this type of construction is the Beauvoir Road in Harrison County, Mississippi, connecting U. S. #90 with the back areas of the county. This road, 18 feet in width and 3 inches thick, carries a large volume of automobile and truck traffic, with loads ranging up to 20 tons. It was constructed in 1942 by county forces at a cost of approximately $3500 per mile. Except for patching of a few small edge failures, there has been no maintenance required. A seal coat is planned for this year.

Construction in Clay Areas

In direct contrast to the sandy soils of the coastal area, the agriculturally rich Mississippi Delta soils are highly active, with an expansion factor of from 40% to 60%. This soil is unsuited for any type road construction, and therefore construction procedure necessarily differs from that followed in the coastal area. However, unlimited quantities of sand are found along the Mississippi River and these deposits make the use of emulsified asphalt sand pavements practical and economical. While the gradation of this sand is far from ideal, having a low minus 200 mesh content, it has been used with excellent results in this area for many years.

Because of the highly plastic nature of the native soil, a minimum of 6-inch compacted clay gravel base is usually placed and primed before constructing the sand-mix surface. It has been found that the extension of the clay gravel base course to the outer edges of the shoulders virtually eliminates damage to the sand-asphalt surface caused by shrinkage cracks in the subsoil during prolonged hot, dry weather.

After the base has been compacted and primed, sand is added in sufficient quantity and windrowed along the side of the road. The mixing procedure is essentially the same as in the coastal area, except that the entire windrow is mixed as one large unit, rather than in several smaller units.

In the hilly sections, deposits of sand and sand-clay-gravel are plentiful. Construction procedures are as outlined above.

The writer believes that if the following precautions are observed, satisfactory results may be expected with emulsified asphalt sand-mix pavements in these regions.

1. The sand or blend of sands used should have a minimum untreated Florida bearing value of 30 pounds.
2. Sand should be free from deleterious materials and should not contain active clay or colloids in appreciable quantity.
3. Sands should be reasonably well graded, but many poorly graded sands composed of sharp, angular particles show a high untreated Florida bearing value and will give excellent results.
4. Since many sands are hydrophilic in nature, an emulsified asphalt which has been treated to adhere to such aggregates will give better results. To obtain rapid and uniform curing, the emulsified asphalt should have a minimum dehydration of 0.60 when tested at 100°F. for 96 hours.
5. Sufficient water should be added to the sand before or during the mixing operation to insure complete dispersion of the emulsified asphalt in the mix.
6. The mix should be thoroughly cured before spreading and rolling to obtain maximum initial stability.

LEADERS IN THE PUBLIC WORKS FIELD

GAIL A. HATHAWAY

Gail A. Hathaway, Special Assistant to the Chief of Engineers, Department of the Army, is the 1951 President of the American Society of Civil Engineers. An internationally known hydraulic engineering specialist, Mr. Hathaway was graduated from Oregon State College in 1922, following service in World War I. During World War, he was special adviser to the Chief Engineer of ETO. He has many interests in engineering aside from his specialty and is broadly recognized as one of the leading civil engineers of the day.

ECONOMIC ASPECTS OF USING SEWAGE SLUDGE FOR FERTILIZER

THE possible production of fertilizer from sewage sludge is discussed in the 1949 report of the Minneapolis-St. Paul Sanitary District, Kerwin L. Mick, Chief Engr. At this plant, normal treatment consists of plain sedimentation, with vacuum filtration of the undigested sludge after concentration. The report, in part, states:

In 1934, D. W. Townsend, consulting engineer who was thoroughly familiar with fertilizer production at the Milwaukee plant, said "Disposal of sludge through its conversion into a commercial fertilizer, such as has been practiced at Milwaukee . . . is a feasible process where the nitrogen content of the sludge is sufficiently substantial to warrant its acceptability to the fertilizer trade, and where geographical location and transportation facilities are such as to favor competitive shipment into the markets. . . .Twin Cities sludge would be worth . . . a price equal to or possibly somewhat lower than the cost of its preparation for the market." The nitrogen content of the sludge produced at this plant averages only about 2%. It has only one-third the fertilizer value of the Milwaukee or Chicago activated sludge, and the Twin Cities are certainly less favorably situated in regard to transportation to the large markets. "The sludge commercialization phase of the problem enters the picture only in the event of the employment of the activated sludge process of treatment."

Detroit Conditions

Even though they are more favorably situated geographically than the Twin Cities, a number of other cities which use or will employ primary sewage treatment have not considered it advisable to go into fertilizer production. These cities include Detroit, Buffalo, Nashville and Pittsburgh. The following is quoted from a printed booklet issued to visitors to the Detroit plant in October, 1948:

"A question that arises in the minds of many visitors is whether the sludge could be made into fertilizer and sold to help defray the operating costs of the plant. This possibility has been given careful study but finally dropped as economically unsound. The raw primary sludge produced by this plant does not have the fertilizing values nor the freedom from pathogenic organisms which sludges at certain other plants acquire by additional treatment processes. To quote from the Federation of Sewage Works Association's Manual: 'Fresh sludge (raw primary) is seldom used and may be troublesome because of grease, odors, and the bacterial content. Digested sludge, whether wet, air-dried, or heat-dried, appears to have application as a substitute for manure and is of about the same fertilizing value. The nitrogen content, however, is relatively low (0.5 to 3%, dry basis) as compared to heat-dried activated sludge (3 to 6% dry basis)'."

A report on plans for a new primary treatment plant at Nashville, Tenn., contains the following statement: "Consideration was given to the preparation of the sludge for fertilizer, but the financial balance and mechanical difficulties presented arguments against this." The Buffalo plant installed equipment at the time of construction over ten years ago to either incinerate the sludge or dry it for fertilizer purposes, but has been disposing of it by incineration only, since that time.

Allegheny County Authority

A report by the Allegheny County Sanitary Authority in January, 1948 on a proposed primary treatment plant for Pittsburgh and the surrounding area concluded that fertilizer production would be unprofitable. The following is quoted from that report:

"Sludge fertilizer is available as an important by-product of sewage treatment processes and, therefore, the matter has been studied with care, especially with a view to making available such fertilizer to the public economically. The popular conception that all sludge fertilizer is good and usable regardless of the type of sewage treatment that is employed is not true.

"It is important if fertilizer is to be produced for marketing, that it shall have a high nitrogenous content. Undigested sludge from the activated sludge process meets this requirement to a greater degree than digested raw sludge which will be available in the type of treatment recommended for the Authority plant. Consequently, the sludge which will be produced in the Authority treatment plant will not be attractive to commercial manufacture of a prepared fertilizer. Manufacture and sale of prepared fertilizers produced from municipal treatment plant sludge may be said to be considered more of an attempt to reduce the over-all cost of sludge disposal rather than as a prospective profitable enterprise . . . it has been concluded that special processing of sludge fertilizer (at the proposed Authority plant) is unprofitable and inadvisable."

In 1946 the Federation of Sewage Works Associations issued a 120-page manual on the "Utilization of

Sewage Sludge as Fertilizer." After studying the history of sewage sludge fertilizer in this country, the committee which prepared the manual concluded that the use of raw primary sludge in any form for fertilizer is not usually recommended; that heat drying of primary digested sludge has been a rare procedure because the low content of plant food does not justify the expense under normal conditions; and that heat dried activated sludge is of value in the fertilizer field. Even in the case of the higher grade activated sludge, however, the revenue from its sale as fertilizer has seldom covered both the operating and fixed charges of the processing equipment, although it may aid considerably in reducing the overall cost of activated sludge disposal.

In 1946 a group of engineers studied the economics of heat drying the filter cake produced at the the Minneapolis-St. Paul plant (assuming that the wet cake would be sold to them at a very nominal price); grinding; and enriching it with various chemicals to produce a processed fertilizer suitable for bagging and sale as a lawn and garden fertilizer similar to Milorganite. They hoped to construct a plant in this immediate vicinity and purchase a portion of the filter cake output. Their preliminary cost estimates were not favorable. In drying the cake approximately two tons of water must be evaporated for every three tons of wet cake, so the cost of drying is high; and the added cost of chemicals which would have to be added to make it comparable to Milorganite as a plant food, resulted in an unfavorable economic picture. The production cost was estimated at $26 per ton of finished fertilizer at that time. This would leave too small a margin of profit to justify the investment required. They reported that Milorganite was also costing about $26 per ton to produce at that time, exclusive of fixed charges on the equipment, while it was being sold to the jobbers at $29 per ton.

In its 1948 bulletin on fertilizer analyses, the Minnesota Department of Agriculture included a table showing the various grades of fertilizer sold for consumption in Minnesota. Out of 28 listings, 17 fertilizers had a wholesale value ranging between $1.23 and $2 per unit of plant food, 8 ranged from $2 to $3 per unit, and 3 exceeded $3. From this it would appear unnecessary for the farmer to pay more than $2 per unit of plant food (wholesale price to dealers) for his fertilizers. As the sludge produced at this (Minneapolis-St. Paul) plant contains an average of three units of plant food (2% nitrogen and 1% available phosphorus, dry basis), it would be worth no more than $6 per ton, dry basis, in competition with more concentrated commercial fertilizers; and actually less than that if the extra hauling cost for the more bulky sludge is deducted. In addition to the three units of plant food, however, the dried sludge contains humus, which is of some value as a soil conditioner. However, the fertilizer trade assigns no monetary unit value to humus, perhaps because its variant composition does not lend itself to exact determination. Under present conditions, therefore, it appears that the sludge from this plant would not have sufficient real value to justify the large additional investment required for drying equipment.

The production cost of fertilizer is estimated at $8 per ton, showing an indicated loss, if fertilizer were manufactured, of $2 per ton. The total cost of incineration is $2.64 per ton. The large investment ($473,200) required for fertilizer production is not justified by the small margin of cost.

PUBLIC WORKS DIGESTS

WATER WORKS . . 77 • HIGHWAYS AND AIRPORTS . . 82 • SEWERAGE AND REFUSE . . 87

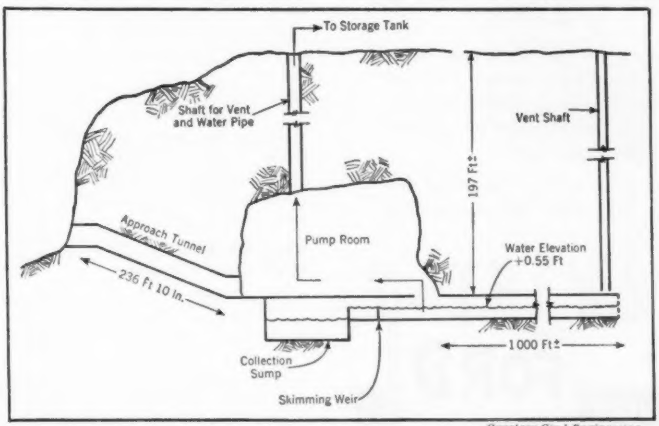
This section digests and briefs the important articles appearing in the periodicals that reached this office prior to the 15th of the previous month. Appended are Bibliographies of all principal articles in these publications.

THE WATER WORKS DIGEST

Horizontal Wells Reduce Salt Water Intrusion

Guam's water supply is drawn from a fresh-water lens which is only about 5 ft. above sea level at the edges and 200 ft. below sea level at the center. For every foot of draw-down there will be an intrusion of about 40 ft. of salt water. Water is drawn from eight wells, 5 of them ordinary deep wells, 1 tapping an underground pool, and 2 are a horizontal type designed to skim fresh water from the top of the lens. An approach tunnel 236 ft. long inclined at a 30° angle enters from the base of a cliff into an underground pump room 17 x 55 ft. and 27 ft. 6 in. high, with an 18" reinforced concrete floor over a collection sump. From this, a horizontal tunnel extends about 1,000 ft. at water table level. Water is pumped by two 1,000 gpm centrifugal pumps and one 300 gpm pump up a shaft into a 420,000-gal. steel storage tank, where it is chlorinated and put into the distribution system. Noxious fumes from the seepage of aviation gasoline from the nearby air field have caused dangerous fires, and a 15" vent shaft 197 ft. deep has been drilled to the far end of the skimming tunnel and an exhaust fan installed there. The pump room is ventilated through a shaft by two large explosion-proof fans.

Joseph F. Fil—"Horizontal Wells Reduce Salt Water Intrusion Into Guam's Water Supply;" *Civil Engineering*, July.



Courtesy Civil Engineering

• ***CROSS-SECTION of well in Guam, showing construction.***

Handling Procedures for Sodium Fluoride

In 1946 Sheboygan, Wis. began treating its water with sodium silicofluoride. To prevent possible contamination of the air with fluoride dust, the charging hopper in the chemical storage room was provided with a suction fan and dust filter, and each operator was provided with a dust mask, to be used when filling the feed machine. To check on the effectiveness of these precautions, the State Bd. of Health was asked to test the air near the feeder and the charging hopper. They reported an insignificant amount of fluoride dust at all points except at the charging hopper during the actual filling. Here they found 8.89 milligrams per cubic meter. The maximum allowable for an 8-hr. day, five days a week, is considered to be 2.5 mg; but as filling the hopper takes less than 5 minutes and never more than once a day, they concluded, therefore, that there was no danger whatever to the operators.

Jerome C. Zufelt—"Fluorides in Air of Water Plant Feeding Sodium Fluoride;" *Water and Sewage Works*, August.

Development of the Delaware River Basin

The Interstate Commission on the Delaware River Basin (known as "Incodel") has received from its engineers a report giving the results of a survey made by it to devise general plans for one or more integrated projects for resolving the problems of stream pollution abatement, water supply, conservation, oyster and fishing resources, recreation, power production and navigation. The most important of these is insuring an adequate supply of potable and industrial water. The studies indicated that there is sufficient drainage area, rainfall and runoff in the basin to meet the

probable future needs of Greater New York, metropolitan New Jersey, Trenton, Camden, Philadelphia and adjacent areas, and also to provide sufficient regulation of flow to improve the river for recreation and prevent the intrusion of sea water up stream.

The plan proposed for this purpose is divided into two stages of construction. The first includes two large reservoirs near the New York-Pennsylvania line, and two tunnels, one 17 mi. long and the other 65 miles, connecting with the New York City water works tunnel. The 65-mile tunnel would be located a relatively short distance from the transmission mains of the Wanaque water supply, Jersey City's supply, Newark's Pequannock system and the Hackensack Water Co.'s system, and can be connected to them and reinforce their existing supply. Storage would be provided for 300 billion gallons and provide a dependable yield of 1038 mgd, of which 400 to 500 mgd would be for water supply, and the remainder would permit raising the natural minimum flow of the river in the driest period to 4,000 cfs at Trenton. The estimated cost of this first stage is $500,000,000, about 40% of which is for the long tunnel.

The second stage would provide for furnishing the Philadelphia area and the South Jersey metropolitan area with a supply from the upper third of the Delaware River Basin, and also increase the supply to New York and North Jersey. A substantial amount of electric power can be developed in connection with this program. More than half of the stored water would be available for flow control, which will prevent salinity of the river at Philadelphia and improve navigation and recreation.

James H. Allen, Malcolm Pirnie and Francis S. Friel—"Development Plans for the Delaware Basin;" *Journal American Water Works Ass'n*, July.

Concrete Conduit for Denver Water Supply

Denver, Colo., has recently placed in operation a 90" concrete pipe conduit to replace two old wood-stave conduits. One 60" wood-stave pipe constructed in 1912 will be retained in service but under reduced pressure. (Incidentally, the water during the spring often has a turbidity exceeding 100 ppm, and to relieve the filters at such time, alum is applied at the river intake and the 12 miles of conduit serves as a long mixing basin and a good floc is formed by the time it reaches the settling reservoir). For the new concrete pipe, made by Lock Joint Pipe Co., the bar type was used for heads up to 112 ft., and the cylinder type for higher heads up to 175 ft. For acceptance test the pipe line was divided into six sections and each section tested for 24 hr. at a pressure equal to the average hydraulic head on that section. The allowable leakage for the bar type was 125 gal. per inch diameter of pipe per mile per 24 hr., and for the cylinder type was 75 gal. All tests showed leakage less than one-third of that allowable.

D. D. Gross—"Denver Completes 90-Inch Concrete Conduit;" *Civil Engineering*, July.

Experience with High-Rate Filtration

Beginning in February 1948, ten of the eighty filter units of Chicago's South Dist. Filtration Plant have been operated at rates of 4, $4\frac{1}{2}$ and 5 gpm and results compared with filters operated at the standard 2 gpm rate. The conclusions reached by May of this year, as given by John R. Baylis, were briefly as fol-

lows: For many waters, filters should be designed for a 3 gpm rate, with hydraulic conditions permitting operation at 5½ to 6 gpm. Increasing the filter rate 50% at Chicago decreased the length of filter runs 35 to 40%. High-rate filters pass coagulated material more readily than low-rate, and a filter should be tested thoroughly at a proposed rate before adopting it. Passage of coagulated material through a filter can be prevented by use of acid-treated sodium silicate.

The saving in cost by designing a filtration plant for a 3 gpm rate instead of 2 gpm would probably average at least 5%. The saving in area of the filters would exceed this, but this would be offset by the greater cost of larger piping and rate controllers. It is pointed out that many existing plants cannot be converted to high-rate filtration because of their hydraulic limitations.

John R. Baylis—"Experience With High-Rate Filtration;" *Journal American Water Works Ass'n.*, July.

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Status of Water Authorities in Pennsylvania. By *Francis S. Friel*, Cons. Engr. July, Pp. 665-674.

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Valve & Hydrant Maintenance. By *Howard W. Niemeyer*, Supt. of Distr., Indianapolis. July, Pp. 680-686.

Experience With High-Rate Filtration. By *John R. Baylis*, Engr. of Water Purif., Chicago. July, Pp. 687-700.

Rockford Ground Water Situation. By *H. F. Smith*, Assoc. Engr., Illinois State Water Survey. July, Pp. 701-706.

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A National Water Policy Needed. July, Pp. 21-23.

Horizontal Wells Reduce Salt Water Intrusion Into Guam's Water Supply. By *Joseph F. Fil*, Ass't Post Engineer. July, Pp. 32-33.

Engineering News-Record

Automatic Chlorination Safeguards Outflow from an Open Reservoir. July 13, Pp. 34-36.

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Boulter Dam. By *Paul F. Howard*, Cons. Engr. July, Pp. 68-76.

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Handling Soft Lake Water at Fort Smith, Ark. By *A. H. Ullrich*, Supt. Water & Sew. Treat., Austin, Tex. August, Pp. 323-325.

Improvements to the Water Works of Madras. August, Pp. 326-329.

Operation of Small Water Plants. By *A. E. Clark*, Mgr. Nashville Suburban Utility Dist. August, Pp. 333-334.

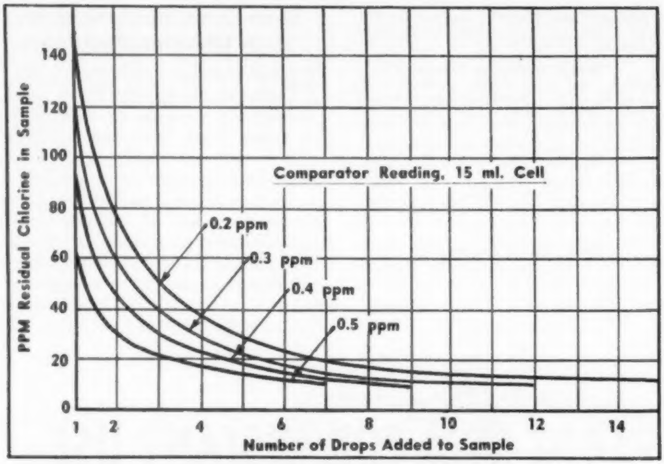
Fluorides in Air of Water Plant Feeding Sodium Fluoride. By *Jerome C. Zufelt*, Supt. Bd. of Water Comm'rs, Sheboygan, Wis. August, Pp. 335-336

Water Works Engineering

New Water Purification Plant at Richmond, Va. By *Marsden C. Smith*, Chf. Water Engr. Pp. 620-622, 661.

Drop Dilution Method for High Chlorine Residuals

HIGH chlorine residuals are usually employed for water main sterilization, and it is difficult to measure them by usual methods and usual equipment. A method, employing an ordinary orthotolidine testing set, has reached us from Douglas Feben of Detroit. Apparatus required include (a) a disc type comparator for residual chlorine determinations; (b) a medicine



● **CHART for use with 15 ml cell. When a 10 ml cell is used, readings are two-thirds of results shown here.**

dropper calibrated to deliver 20 drops per ml; and (c) orthotolidine solution. The curves herewith are based on using a 15 ml cell in the comparator, but a 10 ml cell can be used, in which case readings are two-thirds those shown.

Preliminary procedure is as follows: (a) Clean the comparator cells thoroughly; (b) add clear or distilled water to one cell and use it as the blank in the comparator; (c) add 0.5 ml of orthotolidine solution to the other cell, fill to the mark with distilled water and mix well; (d) flush out the medicine dropper several times with the water to be tested.

Using the medicine dropper, add the water to be tested, a drop at a time, to the cell containing the orthotolidine. Mix thoroughly after adding each drop and count the number of drops necessary to give a color that can be read in the comparator. The developed color should be equal to 0.1 ppm or more. Read the color in the comparator; then refer to the curves and read the residual chlorine of the water tested in parts per million.

Example: Four drops of the water to be tested when added to the orthotolidine solution in a 15 ml cell gives a reading of 0.50 ppm. Refer to the curve marked "0.50 ppm" and note its intersection with the vertical line running upward from "4" drops, indicated at the base of the chart. Where this vertical line intersects the 0.50 ppm curve, follow a horizontal line to the left scale which shows "Ppm Residual Chlorine in Sample". The parts per million of chlorine in the sample will be 38, which is the answer.

Gar Wood Purchases National Truck Equipment Co.

The National Truck Equipment Co. of Waukesha, Wisc., has been purchased by Gar Wood Industries and will be operated as a wholly owned subsidiary. The purchase adds to Gar Wood a line of hoists and lifts adapted to small trucks of less than 1-ton capacity.

The Eschenbrenner Awards

Three annual prizes of $500 each, for senior civil engineering students, have been announced by the Universal Concrete Pipe Co., Columbus, O. The purpose is "to stimulate original thinking in the design, fabrication and use of concrete products." The contest is open to all senior civil engineering students in recognized schools east of the Mississippi River. Papers must be submitted by March 31. One award will go to each of three districts. Details will be available in the fall at college opening time.

Concrete Pipe Machinery Plant

Pictured is part of the new plant of the Concrete Pipe Machinery Company in Sioux City, Iowa. Following destruction of its former plant by fire last January, the new plant is now on full production schedule. The product is McCracken concrete pipe machines, but the company will now also manufacture concrete pipe on a commercial basis. A new model machine will permit manufacture in 6-foot lengths. Plans are to make 6-foot reinforced T & G culvert pipe on this machine with sufficient precision to use Tylox rubber joints. Plain B & S joint sewer pipe in 6-foot lengths in sizes 12- to 24-inches is also contemplated. The new plant will also house the latest model drain tile machine to make butt-end drain tile in sizes 4 to 16 inches, in one or two-foot lengths.

Improved equipment and methods in the new plant make 30-day deliveries a present feature.

Concrete Pipe Machinery plant.

PUBLIC WORKS DIGESTS

THE HIGHWAY and Airport Digest

Factors in Asphalt Mixes

The author believes that a "gap-graded" mix will achieve a higher density than one not so graded when the materials are produced by normal screening operations, which generally contain over and under run of the sizes. Gap grading consists in omitting every alternate size—such as 1-¾, ½-¼, No. 10-No. 200; and would give a denser mix than if the two omitted grades were included. The majority of spaces between particles of the 1"-¾" grading are too small to contain the ¾" to ½" size without spreading but would receive the ½"-¼".

A pavement that is voidless immediately after laying is dangerous. There is evidence that voids of about 5% should be there to be removed by traffic; otherwise traffic will work an excess of asphaltic cement to the surface and necessitate non-skid surface treatment. Coarse non-skid mixes do not stand up well under severe freezing conditions, as water can penetrate below the surface, and wheel chains loosen the larger stones. But mixes all passing the ⅜" screen are not subject to these effects.

If rounded aggregate be used in a penetration job there is no interlocking, and the dynamic stability is due to the binder used. In a dense plant mix, interlocking of aggregate is inconsequential and round material can be used without producing lack of dynamic stability.

N. M. Finkbeiner—"Better Asphalt Pavements Produced by Proper Handling of Plant Mixes;" *Engineering News-Record*, July 13.

Holter System Concrete Roads

In Norway, 53% of the concrete roads have been built by the Holter system, and since World War 2, 90% of the concrete roads and 150,000 sq yd. of airfields. In this process, only cement, sand and water are machine-mixed. The mortar is spread to a uniform depth on the subgrade, and the gravel or broken stone is then spread on this. Sheepsfoot rollers move back and forth over this until the aggregate has been thoroughly kneaded into the mortar. It is then rolled with a heavy, smooth roller, followed by tamping machines, and the surface finished with a smoothing template. Traffic is admitted in one or two days.

"Norwegian Concrete Roads;" *Roads and Road Construction*, July.

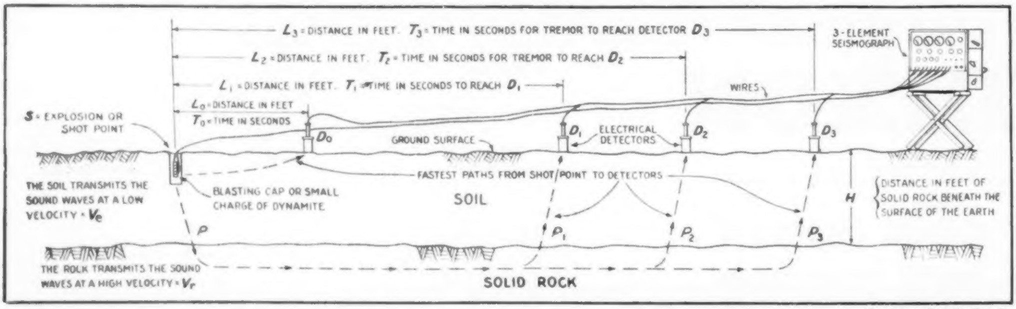
Street Cleanliness

A survey of street sanitation accomplishments and methods was made by the Joliet, Ill. Ass'n of Commerce by means of questionnaires sent to 46 cities in Illinois and four neighboring states. Replies were received from 29, of which 28 said that the streets in their business districts were not kept clean. The 29th city spent $2.25 per capita on street sanitation, compared to the average of $1.29 for all the others—one, with a population of 73,000, spent only $0.49. Generally the larger cities spent less per capita than the smaller ones. Four types of clean-up equipment were used by some of these cities, and at least three types by 72% of them. These were: "Mechanical sweepers, pick-up trucks, sprinkler or flusher units, and trash cans at street corners. Most of the 13 cities using trash cans believed there should be at least two to a block. It was concluded by the investigators that more money should be appropriated for this purpose, more and better equipment used, and more trash pick-ups per week.

C. S. Preston—"28 of 29 Cities Gripe About Dirty Streets;" *PUBLIC WORKS*, August.

Geophysical Subsurface Exploration

Since 1933 the Bureau of Public Roads has had in progress a study of geophysical methods of subsurface exploration as applied to highway engineering problems, including the development of instruments and of methods of interpretation of the data obtained. Both earth-resistivity and refraction seismic apparatus were adapted or developed for use in the shallow subsurface explorations usually associated with highway construction. Special attention was given to the necessity for portable units capable of being transported by hand into areas where reconnaissance surveys might be required. The geophysical methods of test have definitely established



Courtesy Public Roads

● *FUNDAMENTAL principles of the seismograph method.*

their value in connection with highway work, particularly for use in preliminary surveys. Their use by the Bureau of Public Roads and other Federal and State agencies has emphasized the value of these relatively inexpensive methods of shallow subsurface exploration in obtaining information to be used for design purposes or as control for more detailed subsurface surveys by core drilling and other commonly used direct methods. The time required for conducting a seismic test can vary from 1 to 3 hr., and resistivity tests can be made at the rate of 3 per hr. to depths of 60 ft. in rugged mountainous terrain.

When the two methods are used jointly at a given location, a limited amount of confirming data from seismic tests can serve as a valuable check on a considerable number of the more inexpensive resistivity tests, at times obviating the need for test pits or auger holes for locating and identifying subsurface formations. This does not imply that test pits or auger holes may not be necessary for obtaining samples of soil and other materials for determination of their physical and other properties.

In the extensive paper on the subject published by the BPR, they describe in detail the theories of the refraction seismic method and the earth-resistivity method, and the methods of applying them in the field; and illustrations of results obtained in a number of states in connection with highway work, bridge foundations, slide conditions, etc.

The investigation of swamps, peat bogs, and salt-marsh areas by geophysical tests probably constitutes a marginal application of such methods, since simple probings are often effective in these areas. However, since a resistivity depth test to depths of 60 feet can be made in a period of 12 to 15 minutes, the deeper muck deposits can be studied economically in competition with direct probings. Where sand lenses are likely to be present within a relatively deep layer of muck or peat, probings can result in erroneous information, being stopped by relatively thin sand layers. The resistivity test, due to the large volume of material involved, will not be appreciably affected by thin sand lenses and will indicate depth to a true bottom formation.

The seismic test is particularly useful for determining the presence or absence of dense, solid rock. The high velocity usually associated with such formations makes the determination quite dependable.

R. Woodward Moore—"Geophysical Methods of Subsurface Exploration in Highway Construction;" *Public Roads*, August.

Hauling Gravel In Large Trailers

A number of county engineers and other highway officials were asked to comment on the idea of using big trailer-type units to haul gravel or other surfacing material onto their roads. Those who have used them reported that it saves time and money—one up to 40% of normal costs. They say little about the possible damage inflicted by the units on bridges or roads. Other contributors, who so far have had little experience with the large-capacity haulers, are against their use. They say that units carrying as much as 10 cu. yd. of material would be too heavy for weak bridges; that they would damage the roads; that experienced drivers would be hard to find; that altogether the drawbacks would outweigh the possible advantages.

One county engineer reports that

his county has contemplated prohibiting contractors from using semitrailer units on maintenance and construction work. Another believes that trailers might be useful for hauls of 20 miles or more, but points out that units used only for hauling surfacing material may be idle a good part of the time. Nevertheless, where the big equipment has been put into use, the verdict is overwhelmingly in its favor.

"Haul Gravel in Large Trailer Units?;" *Better Roads*, July.

Designing Flexible Pavements

In 1948 Norman W. McLeod, engineer consultant to the Canadian Dept. of Transport, reported that flexible pavement design methods used by the U. S. Corps of Engineers were "unnecessarily conservative" and advocated another method. His method and his criticism of the Corps of Engineers' method were based on field studies of pavements on ten Canadian airfields, which were very much thinner than would be called for by the U. S. method. The engineers directly responsible for the latter method, with the consent of all Canadian officials concerned, inspected the Canadian pavements cited by Dr. McLeod and studied the records of the traffic they had carried. The U. S. design was based on the theory that from 2,000 to 5,000 airplane coverages of traffic are necessary to prove the adequacy of a given pavement thickness. The Canadian records showed that none of the pavements in question had had as much as 3,000 coverages. Eliminating light planes of less than 15,000 lb., the maximum (at Dorval) was 2300, of which only 500 was by planes weighing more than 50,000 lb. The next in order, Malton, had a record of 1,000, with 100 for planes exceeding 50,000 lb. At the latter field, all runways were found to be in a state of either incipient or complete failure, and one was being replaced with portland cement concrete. The investigators concluded that Dr. McLeod's presentation of "an economical method of flexible pavement design'" was premature, since it was based on an inadequate amount of traffic and on fields that had been in service too short a period of time. The records of maintenance at Dorval, and the complete reconstruction at Malton would infer that Dr. McLeod's method of design rather than being economical is indeed a costly method. The inspection developed no information which would indicate a less conservative approach to the design of flexible pavements than that employed by the Corps of Engineers.

"U. S. Runway Pavement Design Defended;" *Engineering News-Record*, August 10.

Highway Flight Strips

An editor of *Roads and Streets* advocates the construction of inexpensive flight strips along every principal highway throughout the United States, at intervals of 20 or 30 miles, by widening the highway right-of-way by 200 or 300 ft. for a length of about a half-mile. The type of surfacing would generally be that used on the secondary roads in the community involved and therefore familiar to both highway officials and contractors. They would be designed for the small, personal type of airplane. The use of these by farmers is increasing rapidly, and the flight strip would be convenient to the farmers and also to business salesmen wishing

to visit them. They would be maintained by the same force in the same way and at the same time, as the highways themselves.

H. K. Glidden—"Highway Flight Strips—The Solution to Private Flying;" *Roads and Streets,* July.

Does Black-Topping Reduce Upkeep Cost?

A number of highway officials, asked whether placing black top on gravel roads increased or decreased maintenance costs, gave various replies. One said that there might be a considerable saving for the first few years but the first reseal or retread job would wipe it out. Another finds maintenance of blacktop much less, except that it runs very high when spring break-up occurs. Kansas finds maintenance cost of low-cost black-top roads is 50% to 75% greater than of gravel roads; but that of high-type bituminous surfaces is greater by only 25% or less.

"Will Black-Topping Reduce Upkeep?"; *Better Roads,* June.

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Engineering News-Record

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AIRPHOTOS FOR ENGINEERING GEOLOGY

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(This is an abstract of a paper presented at the Richmond, Va., Symposium of Geology as applied to Highway Engineering)

MOST soils and foundation work falls within a specialized border line field of engineering—"Soil Mechanics." Settlement of structures from consolidation; support characteristics; and construction materials

are problems for the engineer. Some of these problems may be derived from or governed by the geologic history which, if outlined properly, assists the engineer in the analysis of his problem. Thus geology may serve as an instrument in the initial phase of the solution of many engineering problems

Buildings and bridges cover limited areas only, but even within the confines of these limited areas, radical changes in foundation conditions may exist. When structures, such as airports or highways, extend over thousands of feet or miles many widely varied sub-grade characteristics can be expected. Unfortunately ideal materials may be absent over a wide area and construction sites can not be selected always on a basis of engineering soils for other factors such as topography or right-of-way might govern. In Virginia existing rights-of-way are utilized for new construction in so far as possible to reduce costs. Preliminary to construction all local materials should be mapped so the engineers can improve existing soil conditions where necessary by importing better soils.

The engineer may use several methods of mapping local materials including: field reconnaissance and sampling; a study of geological or agricultural information and maps; or airphoto mapping. Several of these methods have limitations of detail, expense or time involved and frequently result in sketchy or even inaccurate information. Potential borrow pits or quarry sites might be overlooked by field forces simply for lack of information about the expected conditions. To search blindly through an area for soil or rock deposits is time consuming and costly. The best approach is a preliminary mapping of all materials and rock outcrops within a given area, selecting sampling sites, and subsequently securing a few representative field samples to check predictions. This can be done most economically by aerial photographs.

The "finger prints" of a material comprise a pattern which can be considered as a combination of such elements as land form, aerial drainage pattern, erosional features and gully cross-section and gradient, soil color tones, vegetation, man made practices, and other special features. These elements form an airphoto pattern.

By comparing the airphoto pattern of one material to that of another, one can see the pattern elements vary; sometimes the physical features may have such striking contrast that anyone can recognize the obvious differences. Differences in materials, particularly soils, create engineering problems. Thus highway engineers should be interested in soil and soil-rock materials for roads may span many different parent material areas and require large quantities of construction materials. Recognition of the relationship of engineering problems to soils and their parent materials is fundamental. If the aerial distribution of a material is delineated for the engineer he can, in turn, employ his knowledge of engineering properties and select suitable sites and the best available materials.

The airphoto method of mapping engineering materials, recognizing engineering problems, and conducting materials surveys has been adopted by several agencies. During the war it was used for selection of advance air bases in the Pacific Theater of Operations. Since the war, several state agencies have used this method for mapping local materials for highway work.

PUBLIC WORKS DIGESTS

THE WATER WORKS DIGEST

Biological Measure Of Stream Contamination

In a normal stream there is a biodynamic cycle which results in a balance of plant and animal life. The effect of sanitary and industrial pollution is to alter this cycle. If the pollution is not excessive, organisms of this cycle can assimilate it. In studying whether or not an effluent is harmful to a stream, the most common method is to determine for industrial effluents the B.O.D., and for sanitary wastes the B.O.D. and coliform content. But these do not show the toxic effect of a given effluent, nor foretell its actual effect in the stream.

Under healthy conditions in a stream, a great many species representing the various taxonomic groups should be present, but no one should be represented by a great number of individuals. The general effect of pollution seems to be a reduction in species number, with the most tolerant forms surviving. The condition of the water will be indicated by the presence or absence of species of all major taxonomic groups that play a role in the biodynamic cycle (with the exception of bacteria and fungi.) This will reflect the water conditions that have flowed by a given point for a considerable time prior to the time of sampling.

Ruth Patrick—"Biological Measure of Stream Conditions;" *Sewage and Industrial Wastes*, July.

Use of Lime for Treating Acid Wastes

Liming material is usually the most economical alkaline agent for treating acid wastes. In selecting the lime to be used, not only cost and pH performance should be considered but, since contact time between liming material and waste acid may be limited, the reaction rate may become the major factor. The greater cost of a unit of neutralizing value in the form of a hydrate may be more than offset by the saving in storage and handling. Where quicklime is used, the pebble form ranging from 2" to dust is likely to be selected, since it has marked advantages as to unloading, storing and handling. Occasional pieces of tramp iron are almost sure to be found in pebble quicklime, and equipment for applying it should provide for this; screw conveyors are especially liable to injury by it.

Slaked lime in the form of a water slurry is more quickly and completely reacted than if applied in a dry form. The particles should be substantially smaller than 200-mesh screen size. Applying dry lime would eliminate the addition of slaking water to the waste, which increases the volume to be handled, but the technique for this has not been perfected. When slaking dolomite quicklime of the less active form, special effort should be made to hold the slaking temperature above 170° F., even if this means the use of steam or hot water.

Calcium sulfate is quite insoluble as contrasted with magnesium sulfate. In this respect, dolomitic liming materials are especially useful in holding sludge to a minimum where sulfuric acid wastes are involved. In some applications the use of a dolomitic liming material will completely eliminate sludge formation, and has been known to dissolve away heavy scale deposits previously formed from applying high-calcium quicklime. The particular acid waste involved in any disposal process should be thoroughly studied on a laboratory basis with respect to scaling, post-precipitation, and calcium and magnesium solubilities before the choice of liming material is made. The minimum acceptable effluent pH should be established, and adequate reaction time between lime and acid to reach such minimum pH should be provided.

C. J. Lewis and L. J. Yost—"Lime in Waste Acid Treatment;" *Sewage and Industrial Wastes*, July.

Courtesy Sewage & Industrial Wastes

● ***REACTION** ranges for liming materials.*

Treating Cyanide Wastes

So far, no completely acceptable method has been proven in practice for handling extremely dilute cyanide-bearing wastes, some of which contain less than 10 ppm total cyanide. In such dilute solutions in natural waters, cyanide is present to a significant degree in the form of free hydrocyanic acid. The proportion of the total cyanide represented by hydrocyanic acid is determined entirely by the pH value of the solution. Free acid may be present even though a solution is neutral or alkaline. Because certain constituents in the natural water exert a considerable effect on the pH level of the final solution, the quality of the receiving stream

will decide the ratio of hydrocyanic acid to cyanide ion.

David Milne—"Equilibria in Dilute Cyanic Waste Solutions;" *Sewage and Industrial Wastes*, July.

Trickling Filters In Southern Climates

Experiments have been conducted by the Sanitary Research Laboratory of the University of Florida to develop new, or modify existing, design criteria for trickling filters to be operated in southern climates, and to find a cheap, readily available filter medium. The media experimented with included 1½"-2½" blast furnace slag 7 feet deep; pine wood edgings laid criss-cross, 8 ft. deep; 1"-2" Florida limestone, 8 ft. deep; and 1"-2" river gravel, 6 ft. deep. The slag was considered as the standard, the others were investigated as possibly acceptable cheaper substitutes. It was concluded that it may be of economic advantage to construct filters only 4 ft. deep in southern areas; that nitrification depends to some extent upon the type of filter medium and loading rates employed; and that the gravel, although small and smooth, appears to be a suitable medium. A longer test will be required to determine the suitability of limestone and wood.

G. R. Grantham, Earle B. Phelps, W. T. Calaway and D. L. Emerson, Jr.—"Progress Report on Trickling Filter Studies;" *Sewage and Industrial Wastes*, July.

Disposing of Sludge By Chlorination

If sludge can be chlorinated satisfactorily and economically, the possibilities for its discharge into receiving waters are greatly expanded. Research to determine the feasibility of this was undertaken by the civil engineering department of the University of Washington. The problems studied were the necessity for and methods of disintegrating or homogenizing sludge sufficiently for effective chlorination; determination of the chlorine demand for raw and digested sludge; effects on the sludge other than chlorination; and effects of prechlorination of sewage on sterilizing the sludge removed thereafter by primary settling.

As a result of this investigation, it was concluded that both raw and digested sludge can be chlorinated satisfactorily after having been broken up in a laboratory blender. But it is simpler, should be less costly, and is reasonably efficient in chlorine dosage, to prechlorinate the sewage rather than to chlorinate the sludge removed from primary settling tanks.

In chlorinating sludge, dilution appears to favor homogenization but does not increase the chlorination efficiency. The chlorine demand varies directly with the amount of volatile solids in the sludge. The quantity of chlorine per capita for sterilizing sludge was approximately equal for both raw and digested sludge. Chlorination of sludge decreases the pH and improves the settling characteristics of sludge.

Prof. Richard G. Tyler, Gerald T. Orlob and Fred W. Williams—"Chlorination of Raw and Digested Sludge;" *Sewage and Industrial Wastes*, July.

Use of Yeasts in Oxidation of Dairy Wastes

The Eastern Regional Research Laboratory, U. S. Dept. of Agriculture, has studied the use of yeasts in treating dairy wastes to reduce stream pollution. Four yeasts were selected for study, but *Saccharomyces fragilis* gave the most favorable results in reducing the chemical oxygen demand of dilute milk

waste and lactose in the waste. Under proper conditions of aeration and agitation, the greater part of the soluble lactose and casein were converted to insoluble cell material, reducing the B.O.D. of the centrifugal effluent as much as 84 to 93%. The feasibility of using *S. fragilis* in a continuous process for the purification of dilute dairy waste is being investigated on a laboratory scale. The recovered yeast may have some value.

Nandor Porges, Janet B. Pepinsky, Nancy C. Hendler and Sam R. Hoover—"Biochemical Oxidation of Dairy Wastes: Comparative Study of Yeasts;" *Sewage and Industrial Wastes,* July.

E. Coli in Digested Sludge

An investigation was made at the Massachusetts Agricultural Experiment Station to determine the viability of *E. Coli* in drying sewage sludge as an indication of the possible presence of feces-borne pathogenic bacteria, as a basis for evaluating the suitability of the sludge for fertilizer use. It is believed that the absence of *E. Coli* from dried sludge should indicate that there is nothing to fear from the bacilli of typhoid fever or dysentery; but it cannot guarantee safety as to tuberculosis, poliomyelitis, hook worm and amoebic dysentery. *E. Coli* was found to survive barely 7 weeks in sludge stored at 37° C, and just over 2 weeks at about 22° C. Experimental evidence indicated that the organism disappeared because of competition from other microorganisms better adapted to survive in the environment.

James E. Fuller and Warren Litsky—"Escherichia Coli in Digested Sludge;" *Sewage and Industrial Wastes,* July.

Modified Primary Treatment

Plans for treating the sewage of Waterbury, Conn., were made in 1943, but the war prevented construction. In 1948, consideration was renewed, but a review of the changed conditions indicated that changes in the plan were desirable. Copper concentrations up to 120 ppm and averaging 25 ppm, and chromium up to 80 ppm, were found in the sewage; and the pH in 12% of all samples taken was below 4.5, and as low as 3.0 was recorded. It was believed that the copper concentrations would inhibit sludge digestion, and the original plans for heated sludge digestion and sand bed drying were changed to vacuum filtration and drying. Two Eimco vacuum filters will discharge sludge cake to a horizontal conveyor which will convey it to flash-drying equipment or to a storage hopper. The flash dryer will be Combustion Engineering-Superheater equipment designed to dry 3900 lb. of filter cake per hr. at 70% moisture, using hot gas at over 1,000° F from the adjacent Nichols refuse incinerator.

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Modern Sewage Chlorination Plant. By *Arthur E. Nichols*, Westchester Co. Dept. Public Wks. August, Pp. 341-343.

Six Diesels Furnish Power for New Bern

A SIXTH diesel engine has been added to the municipally owned diesel electric power plant of New Bern, N. C. The plant, completed in 1948 at a cost of $600,000, was originally built with five Superior engines; now the sixth, also a Superior, has been installed.

Although the diesel power plant is comparatively new, this Atlantic Coast city of 20,000 inhabitants has owned and operated its own power plant for almost 45 years. New Bern was among the first of the cities in the United States to own and operate an electric power plant. Prior to 1948, the city had used steam turbine-driven generators. In 1947, although operating all available equipment, part of the city's electrical needs had to be purchased. It was this situation which led to the building of the new plant.

Before deciding on diesels, city officials considered three other methods of supplying their power needs: 1) purchasing the power needed; 2) building a new steam plant and moving to the new location the steam equipment then owned; 3) building a diesel plant.

Comprehensive economic studies were made to determine the relative merits and costs of each of these plans. Results showed conclusively that a diesel electric plant would more nearly solve the city's power problems than any of the other alternatives. A contract was let for five Superior supercharged diesels which would develop 1,000 Kw. each.

The sixth engine is a duplicate of

the five originally installed and is a supercharged unit producing 1440 hp. at 360 rpm. It has eight cylinders of 14½-inch bore and 20-inch stroke and is equipped with oil cooled pistons, Woodward hydraulic governor, duplex fuel oil filter, automatic alarm and emergency shut-down systems, and many other modern features.

The lubricating system is a force-feed, dry-sump type with a rotary pump unit mounted at the control end of the engine and driven by silent roller chain from the crankshaft. Lubricating oil cooler is of the shell and tube type.

Houston Electric Log

(*Continued on page* 49)

tomatic treating equipment. One installation, the chlorination building at the Stand-By Plant, consists of a 3-room masonry building. The chlorinator room contains two Wallace and Tiernan automatic chlorinators, with remote control feed provided by a Sparling meter through a converter, and a Wallace and Tiernan automatic chlorine residual recorder. The chlorine room contains ton drums on recording loss-of-weight scales, and the third room is a chlorinator maintenance and repair shop. The completion of the new plants for Heights and North East will put 4 chlorine residual recorders in service.

Prechlorination ahead of the reservoirs continued to be the only treatment required. The average chlorine residual of the water leaving the plants was reduced from 0.79 ppm in 1948 to 0.69 ppm in 1949.

The efficiency of the treatment was checked by 10,221 bacteriological examinations of City water collected regularly throughout the system. The average results of these analyses, determined according to the United States Public Health Service Drinking Water Standards, showed the quality of the water furnished the consumer was excellent.

Cross Connection Control

The policy, begun in 1948, of surveying properties outside the city limits (therefore properties not subject to city plumbing inspection) before allowing city water connections resulted in 807 surveys in 1949. Although the majority of these properties were residences and did not require detailed study, there were many instances where dual supplies and/or cross connections would have resulted if the property had not been inspected.

A most interesting phase of cross connection control in 1949 was a rather extensive study of package-type air conditioning units. These are units which do not employ cooling towers to allow for recirculation of condenser cooling water, and it was found that many of these units were installed with city water directly connected to the condensers and the discharge directly connected to the sanitary sewer. This type cross connection is especially bad; the water demand of the units is high, approximately 3 gpm per ton unit, and this demand taxes the existing water lines of the building and reduces the pressure to such an extent that, in a multi-storied building, a negative head can exist. As a result of this study, new installations of these package-type air conditioning units must be inspected and approved by the Plumbing Inspection Division.

Totals for 1949 show that 39 surveys and 82 resurveys were made. 23 cross connections were located, 17 were eliminated, and 6 were in the process of elimination at the end of the year.

BOOKS IN BRIEF

CIVIL ENGRG HANDBOOK

The revised and enlarged third edition of the Civil Engineering Handbook by Urquhart and others has been published. There are 10 major sections in the book: Surveying; railway, highway and airport engineering; materials; hydraulics; framed structures; steel design; cement and concrete; foundations; sewerage and sewage disposal; and water supply and purification. There are 955 pages in this tome; it is published by McGraw-Hill, New York; and it sells for $8.50.

AGGREGATES & HWY MATERIALS

A special compilation includes all ASTM standards for concrete and concrete aggregates and for non-bituminous highway materials, with pertinent specifications for cement. Of the standards, 13 are specifications and there are 27 test methods and definitions of terms. Including 2 tables of contents, there are 240 pages in these standards. These are published by the ASTM, and sell for $2.25.

TRAFFIC ENGRG HANDBOOK

This is a revised and expanded edition, with contributing authors including 16 leading traffic and transportation engineers; 35 other specialists reviewed the text. There are 205 tables, 215 illustrations; 489 definitions of traffic terms. In its 520 pages, are covered such subjects as traffic accidents, traffic studies, roadway design and capacity, traffic signals, speed regulations and zoning, traffic signs and street and highway lighting. Published by the Ass'n. of Casualty & Surety Companies, this sells for $6.

CLEAN STREAMS IN GEORGIA

One of the finest publications that we have seen from any State Health Department is the multi-colored booklet "Clean Streams in Georgia," a few copies of which are available for distribution on request. The first few pages are intended to inform communities how to proceed to solve the stream pollution problems they create. Then comes the pictorial roll call of Georgia sewage treatment plants; and they are ex-

cellent pictures, too. For this job, lots of credit should go to N. M. deJarnette, Gilbert Frith and Bill Weir. If you want a copy, write quickly to Division of Water Pollution Control, State Department of Health, Atlanta, Ga.

STATE-CITY HIGHWAY RELATIONS

The administrative relationships between state highway departments and cities are considered in this new book. It traces (1) the development of the problem brought on by growing traffic volume in the cities; (2) the authority and scope of state participation, the type of assistance and the activities performed by states; (3) financial and other assistance, and the practices in connection with them; (4) organization studies of state and city departments; (5) working relationships and procedures and programming; and (6) achieving improved relations. By Norman Hebden and Wilbur S. Smith; 226 pages, Yale University Press, $4.

REINFORCED CONCRETE

This is a design book using the problems method approach. It is planned for use by students who are acquiring their basic understanding of reinforced concrete design. In Chapters 2 to 6 are included the "rock-bottom fundamentals" of beam bending, beam shear, columns and practical continuity. Each topic is begun at the elementary level. The result is an exceedingly helpful book for one who must, from time to time, refresh his memory on certain procedures. By G. E. Large, Ohio State University. Profusely illustrated; 327 pages. The Ronald Press. $5.50.

CORRESPONDENCE

SKILLED MAN AVAILABLE

There is working here with us a man who is very highly skilled in instrument repair and glass blowing. The needs for his skills here in Indonesia are very limited and he would, of course, like to better himself. He is a Hollander, under 30 years old, with a family, including two children.

If you know any industry, as a manufacturer or research labora-

tory which might be interested in him, I am sure he would make them a very valuable man. He may be contacted as follows: F. J. Voorzat, Technical Service Div., Standard Vacuum Oil, Palembang, Sumatra, Indonesia.

William L. Avrett,
Sanitary Engineer,
SVPM, Sei Gerong,
Palembang, Indonesia.

(*Ed. Note: It is a pleasure to hear again from Bill Avrett, formerly of Georgia and the Sanitary Corps. We hope that a place may be found where Mr. Voorzat's skills will be utilized most fully.*)

PERSONAL

Benjamin Eisner for the past several years with the Clay Sewer Pipe Association of Columbus, and before that a Consulting Engineer and engineer for the New York World Fair, has severed his connection with the Association.

Frederick H. Weed, who has been engaged in planning and developing the Miami, Fla., metropolitan water system, has become an associate in the firm of Buck, Seifert, & Jost, consulting engineers of New York City.

Jones, Henry & Schoonmaker, Consulting Engineers of Toledo, O., announce the withdrawal of Spencer D. Downing and Bernal H. Swan, junior partners. Mr. Downing is in private consulting work in Bowling Green, O., and Mr. Swab is with Blundon, Snyder & Small of Keyser, W. Va.

DeLeuw, Cather & Co., consulting engineers of Chicago, Ill., have appointed Clinton B. F. Brill, engineer and architect of 101 Park Ave., N. Y., to represent the firm in New England and in Central and South America.

PUBLIC WORKS Equipment News

Street Sweeper Features Safety and Economy

Many features are included in the Mobil-Sweeper, recently added to the Conveyor Co. line. A steel cab and safety windshield are standard equipment. The dirt hopper has a capacity of 2.67 cu. yds., and the

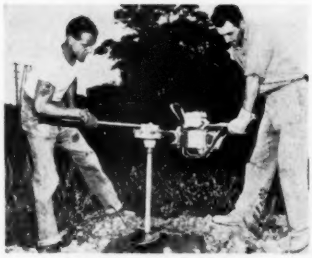
High speed street sweeper.

water tank holds 200 gals. Sweeping speeds are 1½ to 10 mph; maximum highway speed is 55 mph to facilitate travel to and from dumps or disposal areas. Four wheel brakes and short wheel base increase safety and maneuverability. The chassis is a modified International L-1 152R truck chassis, with reduced wheel base, and the engine is also International. Adjustment for broom wear, as well as for angle and pressure, can be made from the driver's seat. Right hand drive is provided for better visibility; when both right and left brooms are furnished, dual controls and steering wheels are available. For complete details write The Conveyor Co., 3220 E. Slauson Ave., Los Angeles 58, Calif., or use the coupon.

Use coupon on page 101; circle No. 9-1

Hole Digger is Portable and Self-Contained

An "earth drill" will dig a 6-inch posthole 30 ins. deep in less than 15 seconds in any earth; and in less than a minute, the unit can be converted into a standard chain saw. The 5-hp engine furnishes the power for both tools. Augers are available in 6, 9 and 12-inch diameters. Chain saw attachments with blades 20 to 60 ins., for use with the earth drill can be obtained separately. Weight of the auger unit



Power post hole digger.

is only 79 pounds, and it can sink a hole at any desired angle. Conversion consists merely of detaching the drill assembly and attaching the chain saw assembly. Descriptive details from McCulloch Motors Corp., Los Angeles, Calif., or by using the coupon.

Use coupon on page 101; circle No. 9-2

Tractor-Loader Digs at Either End

This hydraulic loader, mounted on a wheel tractor, is able to dig at either the front or rear end of the tractor, and to dump always

Digs from either end.

at the front. This leaves the operator free to select the digging end to fit the job. He can load without turning the tractor. Rear digging may have several important advantages, such as increased traction, improved sideways stability and better steering. This loader is available on the Oliver "77" wheel tractor. Bucket sizes are 5/8 and 9/16 yds. Full data from Oliver Corp., Cleveland, O., or by using the coupon.

Use coupon on page 101; circle No. 9-3

Catch Basin Emptier Compresses Load

The "Karrier-Yorkshire" truck-mounted catch basin emptier employs a vacuum to withdraw sand and debris from catch basins, and a hydraulic ram to separate the solids from the dirty water, thus in-

Cuts cleaning costs.

creasing the effective capacity of the storage tank. The unit includes a subdivided tank with compartments for holding water and sludge, a water pump for producing the vacuum and a counterbalanced suction pipe which can be swung to either side or the rear of the vehicle. Dirty water can be returned to the sewer or used for flushing the next catch basin. When the storage space is filled a door at the end of the tank is opened and the load discharged by the ram. Simple accessories adapt the machine for street flushing. Full information from Rootes Motors, Inc., 27-11 Bridge Plaza North, Long Island City 1, N. Y., or by using the coupon.

Use coupon on page 101; circle No. 9-4

Faster and Better Sewer Rodding

A new power machine performs mechanically all of the operations required for rodding a sewer, reducing the cost and speeding the work. This machine rotates special steel rods, pushes the rods, pulls the rods and tugs back loads. It requires only one man and one helper for operation, and can be

operated at speeds up to 100 feet per minute. It requires a space of only 12 ft. back from the manhole and leaves no exposed rod on the street. Called the "SeweRoder", the machine is easily towed. Information from Flexible Sewer-Rod

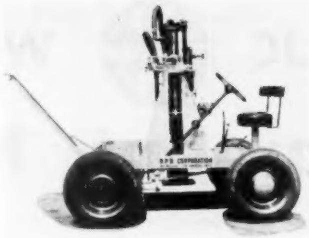
Cleans sewers better.

Equipment Co., 9059 Venice Blvd., Los Angeles 34, Calif., or by using the coupon.

Use coupon on page 101; circle No. 9-5

A Better Pavement Breaker

The new model RPB pavement breaker has a number of improvements, including a 200-lb. head to give a more effective blow, especially in cutting asphalt; a simpler steering device so that it is easier



RPB pavement breaker.

to follow a line; and an automatic attachment for operating the piston rod. The machine is self-propelled and has other features similar to the first midget model introduced about two years ago. Data from RPB Corp., Los Angeles, Calif., or by using the coupon.

Use coupon on page 101; circle No. 9-6

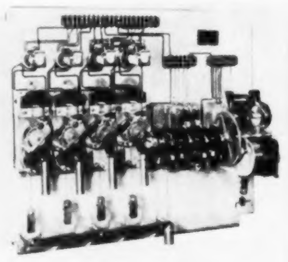
Simpler and Better Airport Marking

"Airguide" is a new type of vitrified clay product used to construct marking circles on airports, as around tetrahedrons and windsocks. The segments are painted with a reflective paint, a special processing of the vitrified clay being applied to insure long adhesion. Each piece of the marker is 6 ft. long, comprising two 3-ft. pieces of semi-circular clay. A luminous circle 100 ft. in diameter is made from 26 segments. A 4-page colorful bulletin tells more about this. Write Robinson Clay Product Co., 65 W. State St., Akron 9, O., or use the coupon.

Use coupon on page 101; circle No. 9-7

Automatic Control of Pumps Saves Money

Originally developed by Marsden C. Smith, Chief Engineer, Dept. of Public Utilities, Richmond, Va., this control can be used to start and stop pumps, to increase or decrease the speed of one or more pumps, to maintain a predetermined pressure at any point or in any district of a distribution system, or to



This will control pumps.

adjust automatically both pressure and flow to suit varying demands. This results in savings in power costs, maintenance of pumps is reduced, and station attendants may be eliminated in some cases. There are also advantages in fire protection. This system of control may be adapted to any distribution system, old or new, simple or complicated. No special design of pumping station is required and external control circuits are eliminated. More information from Builders-Providence, Inc., 345 Harris Ave., Providence 1, R. I., or by using the coupon.

Use coupon on page 101; circle No. 9-8

Cutting Costs on Construction Jobs

Now you can pour concrete into wall forms as high as 15 ft. above ground without erecting a runway alongside the wall. The "A-Frame Roll-O-Hoist" is a mobile, powered, simple device that carries a bucket which may be used for handling concrete or any construction materials. It runs on wheels alongside the forms. Either electric or gasoline power may be used for hoisting the bucket, which runs in chan-

Saves on concreting.

nel guides. The bucket can be stopped and held at any level. Building blocks, mortar, reinforcement or lumber may be raised. Where speed is required and where the hoist structure must be independent of the building, this device will greatly reduce labor cost. Information from St. Anthony Machine Products Co., 2424 E. Franklin Ave., Minneapolis 6, Minn., or by using the coupon.

Use coupon on page 101; circle No. 9-9

Vertical Turbine Pumps, 250 to 15,000 GPM

A new line of vertical turbine pumps has been developed by Worthington. These are either oil or water lubricated, and are arranged for motor drive, right angle gear drive or belt drive. They are suitable for well installation, industrial and municipal water supply, and tank and reservoir service. Pumps are available for practically all conditions of head and capacity. Descriptive bulletins are available from Worthington Pump & Machinery Corp., Turbine Pump Division, Harrison, N. J., or by using the coupon.

Use coupon on page 101; circle No. 9-10

High-Speed Long-Haul Dirtmovers

Two new high capacity dirt moving units are announced by Caterpillar. One is a 4-wheel diesel tractor-wagon combination, the DW20; the tractor engine is 275 hp. The other is a 2-wheel tractor unit, the DW21, which has the same engine. This equipment is especially designed for the heavy construction field where high speeds and large capacity are important. Full information on these units are available

DW 20 Dirtmover

from any Caterpillar dealer, from Caterpillar Tractor Co., Peoria, Ill., or by using the coupon.

Use coupon on page 101; circle No. 9-11

Drill Press has Many Fields of Use

This new 14-inch drill press is available in both floor and bench models It has capacity to drill to center of 14¼-inch circle; maximum drill size ½-in.; spindle runout 0.005 in.; spindle square to table within 0.0075 in. in 5 ins. Table surfaces are precision ground and slotted. Ask for 4-page bulletin NR-8-50 from South Bend Lathe Works, South Bend 22, Ind., or use the coupon.

Use coupon on page 101; circle No. 9-12

Sloper Cuts Road Finishing Time

A fill sloper attachment is available for installation on the Caterpillar No. 12 motor grader. A 5-ft. long wing slides on or off the mold-

Sloper cuts edge of fill.

board, requiring only 5 minutes for attachment or removal. Power control is available through a hydraulic pump. With this attachment, the operator can keep his grader well away from the edge of a soft fill, while blading over the fill edge; and he can complete shoulder grader work in one operation. Also, the attachment can be used to clean up the bottom of a fill slope, cutting high banks out of reach of the moldboard and moving surplus material from the ditch bottoms. A folder is available from Central Construction Co., Indianola, Ind., describing this unit, or you can get the folder by using the coupon.

Use coupon on page 101; circle No. 9-13

Truck Hoist Speeds Loading

An electrically operated mast and boom cable lift hoist for handling heavy materials onto any truck will give a straight vertical lift of 1,000 lbs., or of 2,000 lbs. with a split block and half tackle. It is powered by a small motor beneath the truck bed which draws from the truck battery a negligible amount of current. Control is by remote push button for operator safety. The boom swings through 360°. This lift should be of great value in handling water, sewer and street department equipment and materials. Write Hoist-O-Matic Co., Kansas City, Mo., or use the coupon.

Easier, faster loading.

Use coupon on page 101; circle No. 9-14

Medium Power Grader With Extra Large Tires

A feature of this "501" grader is the use of extra large low-pressure tires to provide additional flotation, traction and performance. The cab has an extra high clearance, with excellent vision. Undercoating is used to reduce noise. Engine is 50 hp, gas or diesel, mounted over the axle. Specifications and performance data from Meili-Blumberg Corp., New Holstein, Wisc., or by using the coupon.

Use coupon on page 101; circle No. 9-15

Pumps for Handling Sewage

The new sewage pumps announced by Allis-Chalmers have a special type of impeller with well rounded inlet edges and large fillets. On the larger pumps, a Francis type vane is used; and this is also used in the smaller pumps where maximum sphere size passage is secondary, as in sludge pumping.

These new pumps cover the range from 175 gpm to 10,000 gpm, with heads up to 150 ft. They are available in iron or bronze fitted construction. Specifications and data from Allis-Chalmers Mfg. Co., Milwaukee, Wisc., or by using the coupon.

Use coupon on page 101; circle No. 9-16

The Cleaning Problem at Sewage Treatment Plants

High pressure steam cleaning is very effective in removing grease, congealed sludge and similar materials on the equipment and structures of a sewage treatment plant. A new combination unit will provide steam at 150 pounds and hot or cold water, as desired. Five of these units have recently been installed at the San Francisco North Point Treatment Plant. Operation is automatic, labor costs should be markedly reduced and better maintenance of the treatment plant assured. An excellent booklet on this subject is available. Write Malsbary Mfg. Co., 845 92nd Ave., Oakland 3, Calif., or use the coupon.

Use coupon on page 101; circle No. 9-17

Getting Rid of the Snow

The favorable weight distribution and short wheelbase of the White 3000 Model motor truck fits it very well for snow removal work. The truck is equipped with dump body and a Good Roads snow plow. Hydraulic controls operate the plow which is easily detachable. Information on this new White truck from White Motor Co., Cleveland 1, Ohio, or by using the coupon.

Use coupon on page 101; circle No. 9-18

Small Riding Tractor for Road Marking

This small, riding-type tractor, with special equipment and attachments for road marking is one-man operated. It travels at 5 to 6 mph, and one tank of paint will mark 5 miles of line. In recent tests, it indicated a saving of 50% over normally used methods of marking parking lines and safety zones. Full data from Beaver Tractor Co., Inc., Stratford, Conn., or by using the coupon.

Use coupon on page 101; circle No. 9-19

Air Pollution & Smoke Prevention.

This is a new association, enlarged from the Smoke Prevention Ass'n. at a recent convention. This change is in line with the modern trend to give consideration to the many factors, besides smoke, which may affect living and health conditions. The secretary-treasurer is Frank A. Chambers, Chief Smoke Inspector, Chicago, Ill.; he can provide broader information on the scope, purpose and facilities of the association.

Iowa County Engineers

The fourth annual meeting of the County Engineers of Iowa will be held at Iowa State College, Ames, Ia., Dec. 6-8. Prof. L. O. Stewart of the College, will furnish information about the meeting.

American Public Works Association

The 56th annual Public Works Congress will be held in New York City Oct. 15 through the 18th. Exhibits will be shown in connection with the equipment show at the Ninth Regiment Armory, while meetings will be held at the Hotel New Yorker. F. H. Zurmuhlen, Commissioner of Public Works of New York City, is the general chairman for the congress. Further information can be obtained from the American Public Works Ass'n., 1313 East 60th St., Chicago 37, Ill.

INDEX OF ADVERTISEMENTS

✓ CHECK THESE FREE CATALOGS NOW!

Mail Coupon to Order Those You Need

These helpful booklets are free. Just circle numbers you want on coupon and mail or write the manufacturer direct and mention PUBLIC WORKS. This service is restricted to those actually employed in public work.

NEW LISTINGS

How the Mobil-Sweeper Can Improve Street Sweeping

23. Sweeping costs can be cut with the new Mobil-Sweeper which features safe highway speeds up to 55 mph, carries 2 2/3 cu. yd. dirt hopper, sweeps swath up to 10' wide with full floating brooms. Hills and deep gutters are no obstacle. Write to The Conveyor Co., 3260 E. Slauson Ave., Los Angeles 58, Calif. or use coupon for complete details on this machine.

Answers to Your Problem Of Brush and Weed Control

43. An interesting bulletin gives answers to problems of brush and weed control for roadsides, parks and right-of-ways by clearly outlining the easy application of Weedone 32 Brush Killer. This potent weed killer has low volatility, hence does not injure nearby susceptible crops. The combination of active ingredients is effective on a great range of woody plants and perennial weeds. For complete description of advantages and applications write American Chemical Paint Co., Ambler, Pa., or use handy coupon.

Ready-Made Furniture Aids Laboratory Layouts

44. Prefabricated convenience and custom quality are combined in Fisher "Unitized" laboratory furniture, available from stock to meet your laboratory needs. Includes work benches, sinks, storage cabinets, fume hoods. etc. Modern design and enduring construction make these units especially suitable for the water works or sewage plant laboratory. Complete catalog F-8 available by using coupon or writing to Fisher Scientific Co., 717 Forbes St., Pittsburgh 19, Pa.

Portable Earth Drill Speeds Fence and Guard Rail Work

84. You can save time drilling holes for guard rail and fence posts by using the high-speed, portable McCulloch Earth Drill. 5-hp gasoline engine provides power for digging in any earth. Converts in less than a minute to standard McCulloch Chain Saw. Get complete information from McCulloch Motors Corp., Los Angeles 45, Calif., or use coupon.

Investigate This Machine For Sewer and Culvert Pipe

92. Machinery for making concrete pipe for sewers and culverts, both plain and reinforced, in sizes 4" to 36", is described in literature of the Concrete Pipe Machinery Co. Either bell and spigot or tongue and groove can be made. The roller head will pack a 4" wall solidly between two lines of steel fabric. Further details from Concrete Pipe Machinery Co., Sioux City 19, Iowa. Use the coupon.

Handy Catalog Covers All Pipe Repairs

167. A complete catalog covering repair clamps, packings and gaskets of several designs to suit all needs is offered by the Smith-Blair Co. Directions for use show ease of application. Every water works needs a copy of this catalog for ready reference. Available by using coupon or writing Smith-Blair, Inc., So. San Francisco, Calif.

How to Make Fluoride Determinations

235. Information on the Hellige Aqua Tester for precise fluoridation control in the range from 0 to 1.6 ppm fluoride is available from Hellige, Inc., 3718 Northern Blvd., Long Island City 1, N. Y., by using coupon.

Data on Design of Grit Collectors and Washers

202. Grit collection and separation of organic materials from settled grit is described in Link-Belt Bulletin 1942. Typical installations are shown, and design data is provided, together with specifications. Use coupon for copy, or write Link-Belt Co., 2045 W. Hunting Park Ave., Philadelphia 40, Pa.

Material and Construction Manual For Corrosion-Resistant Masonry

203. A complete line of acid proof brick or tile and acid and alkali proof cements, plus rubber, plastic and asphaltic lining materials is described in handy manual form. Construction procedures and material selection guide is included, together with useful engineering tables. Get bulletin 810 from U. S. Stoneware Co., Akron 9, Ohio, by using coupon.

Investigate This Compact Flow Meter for Water

226. The Foster "Flow Tube" is a new metering element that is compact and easy to install. Bulletin FT illustrates simple element containing nozzles for differential pressure production and shows capacity range and accuracy. Made in standard type sizes. Foster Engineering Co., Union, N. J. will send copy, or use coupon.

Industrial Waste Treatment By Distillation

227. An interesting discussion of compression distillation which may be used for concentration for disposal of industrial wastes is found in new Cleaver-Brooks Bulletin SP-101. Basic principles including recovery of valuable by-products are outlined. Your copy is available from Cleaver-Brooks Co., 326 East Keefe Ave., Milwaukee 12, Wisc. by using coupon.

Time and Mileage Saving With 2-Way Radiophone

228. The Raytheon FM two-way Radiophone can mean great operating economies in normal maintenance and repair work for all city departments, and is invaluable during emergencies. Investigate the simplified installation of Model UM 30, described in Bulletin WM 15-1. Use coupon or write Raytheon Manufacturing Co., Waltham 54, Mass.

How to Estimate Quantity Of Joint Compound Needed

229. Directions for using Atlas G-K Sewer Joint Compound plus a handy table quantity of compound and jute required per joint of sewer pipe are presented in Bulletin M20-1. Get full data on this permanent joint material from Atlas Mineral Products Co., 10 Pine St., Mertztown, Pa., or use coupon.

Beat Back the Snow With "Caterpillar" Equipment

230. Good advice on meeting the problem of snow fighting is offered in illustrated stories in "Caterpillar's" new 16-page booklet that shows how City, County and State highway departments and road commissions meet the challenge. Be sure you are ready to keep traffic moving. Use handy coupon, or write Caterpillar Tractor Co., Peoria 8, Ill.

Helpful Data on Main Sterilization

231. This detailed discussion of main and emergency sterilization indicates standard procedure, shows how to calculate quantities of sterilizing solution, describes equipment and gives typical specifications. All calculations can be solved by use of a simple chart. Use coupon to get your copy of Bulletin SM-9365. Proportioneers, Inc., P. O. Box 1442, Providence 1, R. I.

Manual for Street Lighting Standards

232. Complete listings of street lighting standards for all mounting heights, single and twin lights, plus foundation details, brackets, fittings, combination street lighting and distribution standards are covered in the Elreco catalog. Use coupon for your copy. The Elreco Corp., 2900 Cormany Ave., Cincinnati 25, Ohio.

How to Stabilize Soft, Marshy Soil

233. An economical and effective method for stabilizing soft, marshy ground by the sand drain method is illustrated in a new folder published by McKiernan-Terry Corp. Investigate this simple method when faced with road, airport or earth dam construction on soft foundations. Write Dept. 32, McKiernan-Terry Corp., 15 Park Row, New York 7, N. Y., or use coupon.

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Please send me the following literature listed in the Readers' Service Dept. of your September issue. (Circle catalogs you need.)

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21	23	24	27	32	33	34	35	40	43	44	46
48	50	51	53	54	58	61	64	70	73	77	84
86	91	92	93	94	95	97	102	106	110	111	114
117	122	123	125	129	130	133	135	137	140	142	143
146	147	148	149	151	153	154	155	157	160	161	162
164	166	167	169	174	175	179	180	184	187	188	189
190	192	195	197	202	203	205	206	219	220	223	224
225	226	227	228	229	230	231	232	233	234	235	

New Products, Pages 95-99:

9-1	9-2	9-3	9-4	9-5	9-6	9-7	9-8	9-9	9-10	9-11	9-12
9-13	9-14	9-15	9-16	9-17	9-18	9-19					

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THIS COUPON NOT GOOD AFTER OCTOBER 31st

Basic Data On Plastic Pipe

234. Helpful tables showing dimensions strength and weight of Carlton Plastic Pipe will introduce you to this newly-developed lightweight, flexible material for domestic and industrial sewerage. Specially adapable to corrosive service. Full data from Carter Products Corp., 10127 Meech Ave., Cleveland 5, Ohio. Use handy coupon.

POWER AND LIGHT

Using Sewage Sludge Gas For Power Generation

27. A new 8-page illustrated bulletin, No. 4811, describes Superior Dual Fuel Diesel engine operation and illustrates the simplicity of controls with fuel conversion by either push buttons or hand lever. Copies are available from Superior Engine Div., Dept. PW, The National Supply Co., Toledo, Ohio.

Air Cooled Engines for Hundreds of Applications

137. Tested under severest conditions of long, hard use, these engines have earned world wide recognition as the "right" power for hundreds of applications. Get latest bulletin from Dept. PW, Briggs and Stratton Corp., Milwaukee 1, Wisc.

Low Cost Power From Dual Fuel Engines

154. Operating on the Diesel cycle, burning either oil or gas, the Worthington Supercharged Dual Fuel Diesels give high economies by running on the cheapest fuel available. Get complete data from Worthington Pump & Machinery Corp., Dept. PW, Harrison, N. J.

CONSTRUCTION EQUIPMENT

Speed Your Work With These Powerful Motor Graders

48. Two powerful Galion motor graders designed to answer every requirement for more speed in road, airport, dam and housing construction work are fully described in a folder illustrated with many action pictures. Issued by Galion Iron Works & Mfg. Co., Galion, Ohio.

How to Keep Your Loader On the Job

50. Don't take more time to move your loader to the job than to do the work. Investigate the Eagle Truck Mounted Loader for handling gravel, sand, cinders, snow from windrows or piles. Get forms 444 and 947 from Eagle Crusher Co., Inc., Galion, Ohio.

Data and Pictures of Complete Line of New Ford Trucks

58. Check this number on the coupon for colorful circular showing new Ford Trucks for every hauling need, available in great variety of standard, factory-built chassis and body combinations. Be sure to check these trucks on your job. Truck and Fleet Sales Dept., Ford Motor Co., Dearborn, Mich.

Handy Catalog Covers Complete Tractor and Grader Line

70. A new 20-page booklet in a handy pocket size features Allis-Chalmers complete industrial tractor line. The importance of wise buying and fitting the equipment to the job is emphasized. Don't miss your copy. Use coupon today. Allis-Chalmers Mfg. Co., Tractor Div., Box 512, Milwaukee, Wis.

Keep That Trench Pumped Really Dry!

93. To find out how well a Homelite Carryable Pump handles large volume, seepage, mud, write today for illustrated bulletin L-503 containing data of great value to all pump users. Write Dept. PW, Homelite Corp., 2110 Riverdale Ave., Port Chester, N. Y.

52-Page Data-Packed Bulletin On Contractors' Pumps

95. Tables for pump size determination on every excavation job, pipe friction loss, attitude effects and lots of other valuable data are included in this comprehensive booklet illustrating the many Jaeger "sure-prime" pump applications. Get your copy (catalog P45) by checking our coupon or writing the Jaeger Machine Co., Dept. PW, Columbus 16, Ohio.

Mack Trucks for Every Road Building Job

184. An illustrated bulletin entitled "Mack Builds the Highways of the Future" tells the story of Mack trucks on the heavy work of highway building and shows how Mack design meets the extra demands of this use. Copies available from Mack Mfg. Corp., Empire State Building, New York 1, N. Y.

Self-Priming Trash Pumps Work "High and Dry"

205. The maintenance difficulties of submerged trash pumps is avoided in the new non-clogging, self-priming trash type sump pumps described and illustrated in Form 9-ST-11, issued by The Gorman-Rupp Co., Mansfield, Ohio. Performance curves and specifications are included.

Two-Way FM Radio Telephone Equipment for All Departments

197. The benefits of two-way radio communciation for all departments of municipalities and counties make full information on this subject important to all engineers. For descriptions of Motorola FM systems, or for specific recommendations concerning your application write to Dept. PW, Motorola, Inc., 4545 Augusta Blvd., Chicago 51, Ill.

WATER WORKS

How to Keep Trenching Jobs on Schedule

24. The easy maneuverability of the tough, compact Cleveland Model 95 "Baby Digger" makes it well suited for the difficult job of trenching past the many obstacles of city and suburban work. Multiple digging and crawler speeds handle all soil types and trench widths up to 24". Get Bulletin S-52 from Cleveland Trencher Co., 20100 St. Clair Ave., Cleveland 17, Ohio.

The Modern, Streamlined Elevated Tank

32. A new 8-page bulletin describes the Watersphere, a modern elevated water tank of welded steel construction for general service gravity water pressure and fire protection. Construction details, illustrations of typical installations and table of standard sizes from 25,000 to 250,000 gallons capacity are included. Check the coupon. Chicago Bridge & Iron Co., 2115 McCormick Bldg., Chicago 4, Ill.

Is Your City Metered 100%?

33. 100% metering as practiced by many cities requires accurate, dependable meters with interchangeable parts. Cut-away views of every part, capacity and size data are all included in handsome American-Niagara water meter booklet available from Buffalo Meter Co., 2920 Main St., Buffalo 14, N. Y.

Data on Modern, High-Rate Water Treatment Plant

40. This handsome 28-page bulletin gives a comprehensive yet understandably written story of the development of the Accelator, and explains its principles, advantages, design considerations, operation and applications. Helpful flow diagrams and specifications. For a copy use the coupon or write Infilco Inc., Box 5033, Tucson,, Ariz. Ask for Bulletin 1825.

Eliminate Taste and Odor From Your Water

53. Technical pub. No. P.W. 213 issued by Wallace & Tiernan Co., Inc., Newark 1, N. J., describes in detail taste and odor control of water with Break-Point Chlorination. Sent free to any operator requesting it.

Improved Clarification with Carter Circular Collectors

61. Latest 16-page bulletin on water and sewage equipment, No. 4906, gives complete data and specifications on Carter's three different types of clarifiers. A valuable working guide for every sanitary engineer. Ralph B. Carter Co., Dept. PW, 188 Atlantic Ave., Hackensack, N. J.

Helpful Data on Hydrants

64. Specifications for standard AWWA fire hydrants with helpful instructions for ordering, installing, repairing, lengthening and using. Issued by M. & H. Valve & Fittings Co., Dept. P.W., Anniston, Ala.

Turbidity, Color and Hardness Removal

77. Modern water pre-treatment with Dorr equipment and methods is described in Bulletin No. 9141, which gives basic design data and flowsheets for pre-treating highly turbid water, color removal or treatment of low turbidity, and softening. Typical analyses for various types of waters are given together with detention times in recommended treatment units. Write The Dorr Co., Dept. PW, Barry Pl., Stamford, Conn.

Flow Meters With Many New Features

91. The new Propelflo meter for main-line metering introduces many new features you will want to look into. Send for latest bulletin today. Builders-Providence, Inc., Box 1342, Providence 1, R. I.

Painting Water Tanks For Longer Protection

94. High labor costs demand special consideration when painting elevated water tanks. This and other factors involved in proper paint selection are discussed in a bulletin issued by Jos. Dixon Crucible Co., Jersey City 3, N. J. Helpful specifications for repainting water tanks are also included.

Cast Iron Pipe Handbook—Handy Pocket Size

97. Catalog of Universal Cast Iron Pipe and Fittings, pocket size, illustrated, including useful reference tables and data. Sent by The Central Foundry Co., Dept. P.W., 386 Fourth Ave., New York 16, N. Y.

Tested Jointing Materials

102. "Hydrotite" is a self-caulking, self-sealing joint compound for bell and spigot pipes. For data book and sample write Hydraulic Development Corp., 50 Church St., New York, N. Y.

Pressure Pipe That Retains Capacity

106. Several bulletins describing the construction of pressure pipe, list of installations, carrying capacity tests, making service connections under pressure; and detail descriptions of several installations. Lock Joint Pipe Co., Box 269, East Orange, N. J.

How to Make Metal Cutting Faster, More Efficient

123. Pipe up to 10", structural shapes and heavy solid stock can be cut with speed, ease and perfect accuracy with the Johnson metal cut-off band saw. If you are not familiar with this modern machine get free data now by using handy coupon, or write Johnson Mfg. Corp., Albion, Mich.

How Short Coupled Turbine Pumps Are Used

125. Ease of installation and dependable service make short coupled vertical turbine pumps particularly desirable for many municipal pumping jobs. Bulletin SCP-50 shows application of Layne pumps for lake and river intakes, fire pumps, drainage, pipe line boosters and many other uses. Check coupon for your copy of this valuable booklet. Layne & Bowler, Inc., Memphis 8, Tenn.

The Modern Way to Filter Swimming Pool Water

129. That's the title of a bulletin full of facts about Bowsers' new diatomite filter to produce clear, sparkling, clean water at low cost. Occupies small space, doesn't waste water. Gives sizes to use, performance charts, etc. Write Bowser, Inc., Dept. PW, 1395 Creighton Ave., Ft. Wayne, Ind.

How Accurate Boring Speeds Underground Pipe Installations

135. Interesting charts showing earth boring costs, speed and accuracy for holes from 2½" to 14½" diameter and up to 80 feet long are included in 16-page Catalog No. 8 issued by Hydrauger Corp., 681 Market St., San Francisco 5, Calif. Specifications and general operating instructions are also covered.

Faster Pipe Laying With Precaulked and Threaded Joints

140. McWane 2" cast iron water pipe with threaded joints and precaulked bell and spigot pipe are described in folder WM-47. Additional data on 3" to 12" centrifugally cast pipe and fittings in folder WL-47, both issued by McWane Cast Iron Pipe Co., Birmingham 2, Ala.

Easily Cleaned, Long Run Filter Bed Media

140. Bulletins on Anthrafilt tell the reasons why selected, graded crushed anthracite is superior to sand as a filtering material. Have you made a full investigation? Write Anthracite Equipment Corp., Wilkes-Barre, Pa.

Complete Equipment for The Complete Pool

157. Latest equipment for recirculation, filtration, chlorination, softening and pH control are described in Permutit Bulletin No. 2157. Manual and automatic valves explained and many installations diagrammed. Complete specifications given. Permutit Co., 330 West 42nd St., New York 18, N. Y.

Easy Way to Locate Leaks In Underground Pipe

160. Fast and accurate leak detection pays dividends in water savings and avoidance of needless digging. For data on the "Universal" Leak Locator write Leak Detector Co., 625 Hanna Bldg., Cleveland 15, Ohio.

Helpful Data on Corporation Stops

161. A complete line of brass goods for water works: corporation stops, curb stops, service pipe couplings, goosenecks and other fittings are illustrated and described in catalog W-39, issued by A. Y. McDonald Mfg. Co., Dubuque, Iowa. Get your copy for ready reference.

What You Should Know About Meter Setting and Testing Equipment

166. Complete details on all equipment and proper methods for meter testing and installation are included in an excellent book published by Ford Meter Box Co., Wabash, Ind. All waterworks men concerned with setting and testing of water meters should have a copy of this book. Write for Catalog No. 50.

Fabrication with Everdur For Long-Range Economy

169. Corrosion-resistant Everdur alloys are available in all wrought commercial shapes suited for dozens of applications in water and sewage plants. Many examples shown in Publication E-11 issued by The American Brass Co., Waterbury 20, Conn.

Handy Calculator for Cast Iron Pipe

175. With the handy Cast Iron Pipe Calculator you can determine at a glance the class, weight and dimensions of bell and spigot pipe. This slide-rule type calculator is absolutely free. Use coupon or write R. D. Wood Company, Public Ledger Bldg., Philadelphia 5, Pa.

How Your Filter Washing Can Be Improved

188. More thorough sand washing with the elimination of mud balls and cracking with resultant longer filter runs are claimed for the Palmer Filter Bed Agitator, described in bulletins issued by the Palmer Filter Equipment Co., P. O. Box 1655, Erie, Pa.

Installation Guide for Transite Pressure Pipe

192. A convenient, pocket-size book of 115 pages covers the whole job from receiving and handling pipe to pressure and leakage tests of finished lines. Over 100 drawings show important operations, and the text tells both how and why. Copies are available from Johns-Manville, Dept. PW, 22 E. 40th St., New York 16, N. Y.

Here's Data on Fluoride To Combat Tooth Decay

223. Technical data for municipalities interested in the use of sodium fluoride for addition to water supplies is available from the General Chemical Div., Allied Chemical & Dye Corp., 40 Rector St., New York 6, N. Y. Information includes data from communities now using fluoride to reduce tooth decay.

Does Your Water Works Have Standby Power?

224. Dependable Climax power plants are ready for emergency service to insure fire protection, and can also save power costs by peak load operation. Use the coupon for full data on Climax, 40 to 495 HP, operating on sewage or natural gas, butane or gasoline. Climax Engine & Pump Mfg. Co., Clinton, Iowa.

REFUSE COLLECTION AND DISPOSAL

New Unit Cleans Catch Basins in a Jiffy

34. Simple powerful pneumatic bucket is featured by Netco Catch Basin Cleaner. Folder 33A gives details and illustrates operation of complete self powered truck mounted unit. Netco Div., Clark-Wilcox Co., 118 Western Ave., Boston 34, Mass.

How to Lower Costs Of Refuse Collection

35. For saving trucks, labor and time in city rubbish collection get details of the new Dumpster-Kolector described in literature just published by Dempster Bros., Inc., 980 Dempster Bldg., Knoxville 17, Tenn.

Efficient Material Handling to Reduce Incineration Costs

130. Blaw-Knox Buckets specially designed for refuse and garbage handling are described in 22-page Bulletin 2247. Illustrations show progress of material through a modern municipal incinerator plant. Dimensions and incinerator bucket specifications are included. Blaw-Knox Div., 2124 Farmers Bank Bldg., Pittsburgh 22, Pa.

How to Build and Operate A Sanitary Fill

146. A complete discussion of many types of sanitary fill construction, together with cost data from communities of all sizes, is offered by the Drott Mfg. Corp. Get this valuable presentation on the Drott Bullclam and International Crawler tractor combination, specially designed for all phases of sanitary fill work, by checking the handy coupon, or write Drott Mfg. Corp., Milwaukee 8, Wis.

Investigate This Plan For Garbage Elimination

164. A new presentation, written especially for municipal officials, offers a modern solution for the garbage disposal problem. Be sure you have this up-to-date information on the elimination of city garbage collection by the use of Hotpoint Disposall units. Check the coupon now. Hotpoint Disposall Department, 5600 West Taylor St., Chicago 44, Ill.

How to Reduce Cost of Garbage Collection

206. Lower costs for trucks, bodies, operation and maintenance are featured by the Pax-All packer type year-round rubbish collector. Use coupon to get full details from St. Paul Div., Gar Wood Industries, Inc., 2207 University Ave., SE, Minneapolis 14, Minn.

STREETS AND HIGHWAYS

How to Select the Proper Sno-Plow for Your Truck

21. Fully illustrated 24-page catalog on Frink Sno-Plows includes valuable tables on proper plow and leveling wing selection for mounting on all size trucks. Detailed discussions cover special features which result in performance plus economy. Use coupon for copy. Frink Sno-Plows, Inc., Clayton, 1000 Islands, N. Y.

Need Street, Sewer or Water Castings?

51. Street, sewer and water castings in various styles, sizes and weights. Manhole covers and steps, inlets and gratings, adjustable curb inlets, water meter covers, cistern and coal hole covers, gutter crossing plates, valve and lamphole covers, etc. Described in catalog PW issued by South Bend Foundry Co., South Bend 23, Ind.

Reference Manual on Guardrail Design

114. Here is an interesting and informative booklet in which all factors influencing guardrail design are outlined, and safety and economy discussed in detail. Eight pages are devoted to basic design data, with handy tables covering physical properties, tensile and beam strengths, deflection and other data. Write Armco Drainage and Metal Products, Inc., Dept. PW, Middletown, Ohio.

Chemical Stops Salt Corrosion

174. A new chemical has been developed which, when mixed 1 pound to 100 pounds of salt, prevents any corrosion of automobiles by the salt. Harmless; colorless; odorless. Permits free use of salt for ice and snow control without complaint by drivers. Calgon, Inc., Pittsburgh, Pa.

Heating, Thawing and Melting With Hauck Burner Equipment

142. A newly released 16-page bulletin covers the complete line of Hauck heating and melting equipment. Data covers units for every water, sewer and street department purpose, from "one-man" burners to large size portable kettles. A useful addition to your reference file. Get Bulletin 1068 from Hauck Mfg. Co., 117-127 Tenth St., Brooklyn 15, N. Y.

How to Save Time on Curb and Gutter Work

143. Every type of curb and gutter work is illustrated in the 12-page Heltzel catalog on steel forms for building concrete curbs, gutters and sidewalks. Time-saving setups show how to speed up the job and save money. Get your copy from Heltzel Steel Form & Iron Co., Dept., PW, Warren, Ohio.

Road Widening With Concrete, Bituminous Mix or Gravel

149. All types of road building materials are handled quickly and accurately by Apsco Wideners. New illustrated bulletin shows operations on all types of widening strips, gives details on wideners and trench rollers. Issued by All Purpose Spreader Co., Elyria, Ohio.

Versatile Maintainer Has Year 'Round Usefulness

151. A new bulletin shows how the sturdy Huber Maintainer will work for you the year 'round on maintenance jobs, berm leveling, road planing, bull-dozing, snow plowing, brooming, mowing shoulders and as a patch roller. Good ideas on how to do all these jobs in Bulletin No. M-138. Write Huber Manufacturing Co., Dept. PW, Marion, Ohio.

How You Can Improve Your City's Street Cleaning

162. The Austin-Western Model 40 sweeper features three wheel design, front wheel steer, for easy maneuvering; rear broom to sweep dirt and refuse directly into 2-yd. hopper; built-in flushing device. Diagrams showing all operations and full specifications in Bulletin AD-2042, issued by Austin-Western Co., Aurora, Ill.

End Dangerous Ice Hazards

179. Ice prevention on highways, streets and airport runways with Sterling "Auger Action" rock salt is described in illustrated bulletin PW issued by International Salt Co., Inc., Scranton, Pa.

Useful Data for Highway Builders In Barrett Road Book

190. The latest edition of "The Barrett Road Book" has 54 pages of helpful tables and step-by-step outlines of highway maintenance and construction with Tarvia and Tarvia-lithic. Tables show quantities per yard and mile; aggregate gradings; costs; many others. Get this useful book from Barrett Div., Allied Chemical & Dye Corp., 40 Rector St., New York 6, N. Y.

Helpful "How To Use" Section Aids Roller Selection

195. In addition to specification and illustrations of roller operation, the new Buffalo-Springfield catalog features a special section to help in the selection of the right roller model for the job. Be sure you get top results from your roller selection by checking this helpful material. Use the coupon for a copy. Buffalo-Springfield Roller Co., Springfield, Ohio.

Investigate "Package" Bridges To Speed Construction and Save Money

219. Three basic elements of precast reinforced concrete—cribbing, bridge seat and bridge deck slabs—are combined for construction of bridges up to 40' span. Details of the units, and a construction story in step-by-step pictures are contained in the new PB-50 Bulletin issued by Universal Concrete Pipe Co., Columbus 15, Ohio. The handy coupon will get your copy quickly.

The Easier Way For Pavement Breaking

220. Rapid Pavement breaking the low cost way is described in bulletins issued by the R.P.B. Corp., 2751 East 11th St., Los Angeles, Calif. Both "Mighty Midget" and heavy-duty truck-mounted models make quick, clean cuts, break trench openings or tamp backfill. Use coupon for full data.

SEWERAGE AND WASTE TREATMENT

A Handbook of Sewer Cleaning Equipment and Methods

46. A new, fully illustrated 40-page booklet shows every sewer cleaning operation with "Flexible" tools. Includes data on the fast and easily operated new Sewe RodeR and full engineers' specifications for power bucket machines. For your copy write Flexible Sewer Rod Equipment Co., 9059 Venice Blvd., Los Angeles 34. Calif.

How You Can Dispose Of Sewage Solids

54. Nichols Herreshoff incinerator for complete disposal of sewage solids and industrial wastes—a new booklet illustrates and explains how this Nichols incinerator works. Pictures recent installations. Write Dept. PW, Nichols Engineering and Research Corp., 70 Pine St., New York 5, N. Y.

Recording Meters for Parabolic Flumes

73. Engineering data on parabolic flumes and accurate companion meters for open flow water and sewage metering is given in Simplex bulletin 210. Installation data and calibration included. Write Simplex Valve and Meter Co. Dept. 4, 6750 Upland St., Philadelphia 42. Pa.

Vitrified, Salt Glazed Filter Bed Block

86. An 8-page folder contains instructive design applications and detailed descriptions of Dickey underdrain tile for filter bed bottoms. Diagrams show how air passes up through blocks for filter ventilation. Issued by W. S. Dickey Clay Mfg. Co., 922 Walnut St., Kansas City 6, Mo.

Complete Catalog for Engineers Shows Sewage Plant Equipment

110. A complete, 44-page catalog gives engineering data on Jeffrey equipment for water, sewage and industrial waste treatment plants including screening, screenings grinders, grit collectors and washers, settling tank collectors, feeders, Floctrols, mixers and other mechanical equipment. Use coupon to get Catalog 775-A, Jeffrey Mfg. Co., Columbus 16, Ohio.

How to Improve Coagulation and Sludge Conditioning

111. "Ferri-Floc," description and instructions for use in coagulation, sludge conditioning and treating industrial wastes, fully treated in a 24-page pamphlet. Tennessee Corp., 619-27 Grant Bldg., Atlanta 1, Ga.

Be Sure to Check These Digester Features

117. Floating covers for digesters, their advantages and details of construction, and suggestions for digester operation are contained in a 42-page catalog. Write Pacific Flush-Tank Co., Dept. PW, 4241 Ravenswood Ave., Chicago 13, Ill.

Need Low-Cost Air For Sewage Treatment?

122. New 20-page booklet shows operating and construction features of Rotary Positive Blowers engineered to fit your needs. Air for activated sludge, water treatment; constant vacuum for filtering. Bulletin 22-23-B-13 gives details. Roots-Connersville Blower Corp., 508 Poplar Ave., Connersville, Ind.

Durable Gratings and Treads Are a Good Investment

147. Gratings for walks around settling tanks and other parts of treatment plants, both out-doors and in, for stairways, floors and balconies, are described in an illustrated 16-page bulletin by Irving Subway Grating Co., 5053 27th St., Long Island City 1, N. Y.

Helpful Painting Chart For Sewage Plants

153. Specific data on surface preparation and priming, and a handy chart showing the proper type of paint for all surfaces and sewage plant conditions are included in new Bulletin 586 published by Inertol Co., Inc., 480 Frelinghuysen Ave., Newark 5, N. J.

What You Should Know About Filter Underdrains

155. Specifications and construction details for the use of "Bosco" trickling filter floor underdrain blocks are available in literature published by Bowerston Shale Co., Bowerston, Ohio. Information on special fittings and angle blocks also included in 12-page booklet.

Conkey Filters for Sewage Sludge Disposal

180. Development of Conkey sludge filters and applications to all types of sewage sludge are described in Bulletin 100. Tables show filter sizes, weights, and give average anticipated results. Write General American Transportation Corp., Process Equip. Div., 10 East 49th St., New York 17, N. Y.

Air for Activated Sludge and Other Aeration Processes

187. Quiet operation, high efficiency and compact size are features of the Chicago "Standardaire" positive displacement blower. Wide range of capacities available to fit your needs. Details and performance data from Chicago Pump Co., 2348 Wolfram Ave., Chicago 18, Ill.

Eight Advantages of Vacuum Sludge Dewatering

189. Efficient sewage treatment requires economical sludge disposal. Eight advantages of vacuum dewatering of sewage sludge are described in a new folder issued by the Eimco Corp., Salt Lake City 8, Utah. Use the coupon for your free copy.

Vacuum Filter Design Data

225. Typical flow diagrams, details of operation, power requirements and standard sizes of individual units and "package" units of the Oliver Sewage Sludge Dewaterer are presented in Bulletin 219. Check coupon for your copy. Oliver United Filters, Inc., 33 W. 42nd St., New York, N. Y.

WORTH TELLING . . . By Arthur K. Akers

The Baldwin Locomotive Works, of Philadelphia, announces **R. B. Crean** as newly-elected vice president in charge of apparatus sales, including Diesel engines. **R. S. Oberlander** is manager of the Diesel department, and **George F. Walsh** will sales-promote them. Sorry we lack the latter's picture but the July 28 NEW YORK TIMES had a good one.


Mr. Crean


Mr. Oberlander

•

Gorman-Rupp's new department specializing in development of small centrifugal pumps has **Edward M. Smith** as hydraulic engineer and **Horace M. Montgomery,** project engineer.

•

W. E. Robinson, president of **Robinson Clay Product Company,** Akron, Ohio, is the new president of the National Clay Pipe Manufacturers Association, with **D. M. Strickland** of Cincinnati as vice president and **John D. Cook,** Chicago, secretary-treasurer.

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R. A. Dittbrenner, an expert on corrosion and erosion, formerly with the **Duriron Company,** is now eastern representative and advertising manager of **Carboline Company,** St. Louis, with headquarters in New York.

•

New appointments at **Graver Water Conditioning Co.** include **James T. Potter,** sales representative for the Carolinas, and **Evans L. Shuff & Associates,** for the Atlanta territory.

•


Mr. Hunkele

H. J. Hunkele, Jr., is the new assistant manager of sales engineering division, **Caterpillar Tractor Co.,** at Peoria, Ill.

"Why do we have 8,000,000 trucks on the highways today? Because the public wants them there," declared President **E. D. Bransome** of **Mack Trucks** before the Los Angeles Rotary Club. This year the company is celebrating its Golden Anniversary which included a "then and now" exhibit of Macks in Grand Central Palace, New York that dramatized progress of fifty years.

•

Robert F. Orth, manager of **Johns-Manville's** Transite pipe department, takes over from **Reginald F. Hayes** of **Hydrotite** on January 1 the honors and headaches of president of the Water & Sewage Works Manufacturers' Association. **E. M. ("Casey") Jones,** vice president of **Simplex Valve and Meter Co.,** will be vice president; **Edgar J. Buttenheim,** president of **The American City,** remains treasurer.

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McCulloch Motors, Los Angeles, announces appointment of **Lewis S. Peck** as personnel manager, and promotion of **Jean St. Henri** and **Kenneth Mulkey** to factory sales representatives.

•


Mr. Peck


Mr. Twist

Gerald F. Twist, manager of Food Machinery & Chemical Company's **Peerless Pump Division,** has been elected a vice president of the corporation.

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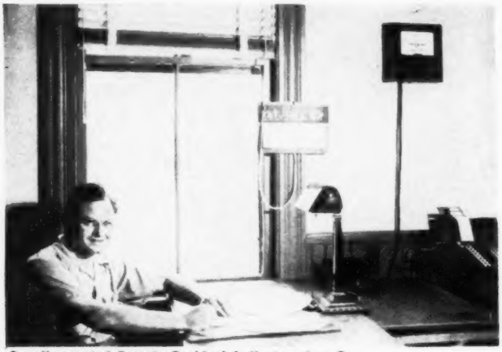
Infilco Inc. is moving its general offices and certain divisions to Tucson Arizona, where a new building which is under construction will house them.

•

Robert W. Ballantine, advertising manager of **Neptune Meter Co.,** announces **Wentworth Smith** as new assistant general sales manager, vice James H. Judge, resigned.

W&T RESIDUAL RECORDER

Aids Chlorination Control at NEW HAVEN Filter Plant

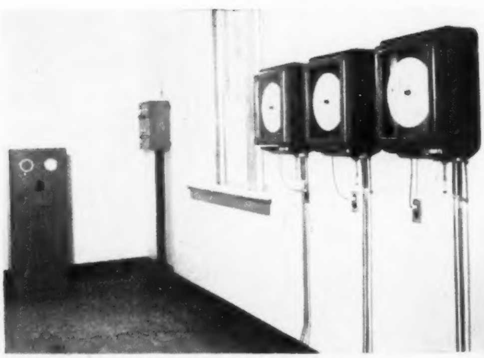


A wall mounted Remote Residual Indicator gives Dr. Samuel Jacobson, Chemist at Lake Whitney Filter Plant, a direct residual reading in his office.

At the Lake Whitney Filter Plant of the New Haven Water Company a W&T Residual Recorder furnishes a *permanent, continuous record* in ppm of the free chlorine residual ahead of the slow sand filters. At any instant the plant operator can read the chlorine residual directly from the Recorder Chart, make any adjustments required, and then check the results by again reading the Recorder—all in a matter of minutes. Thus, changes in the raw water quality or pumping rates can be compensated for immediately, and fast, precision control obtained—the kind of control that helped chlorination to increase filter runs by several months at New Haven and upped filter capacity by as much as 72%.

Wallace & Tiernan Residual Chlorine Recorder at Lake Whitney Filter Plant.

New Haven's experience, however, gives only one example of the ability of the Recorder. This same instrument is successfully at work in other cities of all sizes. Bellevue, Pennsylvania; Bellingham, Washington; Cleveland, Ohio; Kansas City, Missouri; and Atlanta, Georgia—to name only a few—are all now enjoying the benefits of residual recording.



Wallace & Tiernan Chlorine Flow Recorders at the Pre-Chlorination Station of the Lake Whitney Filter Plant.

Find out now from your nearest W&T Representative how the W&T Residual Recorder—by furnishing a permanent record of performance—can bring you such advantages as better chlorination control, improved chlorine usage, and increased operating efficiency.

WALLACE & TIERNAN
COMPANY, INC.
CHLORINE AND CHEMICAL CONTROL EQUIPMENT
NEWARK 1, NEW JERSEY • REPRESENTED IN PRINCIPAL CITIES